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# NOTES AND COMMENTS.

## The Teaching University for London.

THE Government must be congratulated on its action in regard to the proposed Gresham University for its reference of the Charter back to the Privy Council, with the understanding that it is to be submitted to another Royal Commission. To some of the opponents of the proposed Charter this has not given complete satisfaction, though it is difficult to see what more could have been expected. The new Commission is to be made even stronger than the last, and to it (in the words of Mr. Balfour) is to be "referred the question of establishing a teaching university for London *upon a broad basis*." This remark shows that Mr. Balfour and the educationalists in the Government fully realise the weak point in the late scheme, and it is to be hoped that the friends of University teaching will be content to work for the improvement of the scheme in this respect, instead of continuing the theological protest against King's College, which has already done so much to handicap the agitation against the now rejected Charter.

## The Water Supply of London.

The subject of Water Supply to towns and villages becomes every year more important, and as local sources fail in amount or in quality, the selection of sites for new supplies must engage serious attention. It is often impossible for villages to undertake deep borings or expensive reservoir works, and the time will probably soon come when the whole country must be divided into separate and co-operative districts to furnish drinking-water to groups of villages or towns that need new or more copious supplies.

London itself is provided with water only for present needs, and it is necessary to be prepared for the further growth of its vast population. It is well-known that the amounts of water that can be drawn from the Thames and Lea, and from various wells, have nearly reached their maximum. The average daily amount taken from the Thames above Teddington Weir is about 100 million gallons; the minimum daily discharge of water over the Weir is sometimes no more than 153 millions of gallons, although the maximum discharge may exceed 3,000 million gallons, even in the month of August, and is sometimes more than double this amount. The daily maximum amount of water taken from the Thames by the several water companies should not exceed 130 million gallons; for if more were abstracted, the navigation might be impeded, while the sewage in the lower Thames would not, in dry seasons, be adequately carried away. The Lea is even more seriously drawn upon than the Thames.

The Chalk under London can no longer be looked upon as a source of great additional supplies of water. This is already utilised by upwards of 200 wells, and while at the commencement of the century the water, when tapped, rose in many places to the surface, it stands now at a level of about forty feet below Trinity high-water mark. It is considered that the rate of depression now varies from one to two feet per annum.

The effect of the continuous pumping of water from the Chalk has thus been to lower the plane of saturation, whereby the flow of distant springs and streams has been more or less seriously affected. Practically, the amount of water pumped from the Chalk under London is so much taken from the streams that are fed by the natural overflow from that formation.

Various schemes have been propounded to supplant and supplement the present sources of water supply for London. It has been suggested that a number of reservoirs be constructed in the upper Thames Valley to retain much of the surplus water in flood seasons, so that it might be sent down, as occasion required, during periods of drought. There has also been a proposal to obtain water at a distance, by means of lakes or reservoirs among the Cumberland or Welsh mountains, or on Dartmoor.

There is no question but that the present supplies of water for London must be maintained, for their quality is good, and no distant sources could be considered satisfactory in times of disturbance. Additional water will, however, ere long be urgently needed, and it is very important to consider the remote sources that might be available, as Birmingham and other large towns and cities are selecting sites for supplies from our mountain regions.

Birmingham has been provided with water from wells in the New Red Sandstone, and from surface-water stored in reservoirs. It is now proposed to construct five reservoirs along the rivers Elan

and Claerwen, tributaries of the Wye, and to form the main compensation reservoir at Caban Coch, just below the junction of the two tributary streams. The sites for these reservoirs are on highly cleaved slates and thick massive grits belonging to the Ordovician or Lower Silurian system. The proposal is, in the first instance, to convey 27 million gallons of water daily to Birmingham, but the area will yield much more than that amount if required. The top of the dam of the Caban Coch reservoir would be 820 feet above Ordnance Datum, and the water could be delivered to a distributing reservoir at Frankley, at a height of 600 feet. As Birmingham stands at a high level, near the centre of England, the importance of the gathering ground that has been suggested is manifest. With regard to London, sites for reservoirs might be selected at a lower altitude.

The question of supplementary supplies for London has been partially considered in connection with the London Water Commission Bill, the Special Report on which was printed in July, 1891. It remains, however, for special and practicable schemes to be considered in detail by a committee of experts, and we understand that a Royal Commission has just been appointed for the discussion of the subject. This includes the well-known names of Sir G. Barclay Bruce, Professor James Dewar, F.R.S., Sir Archibald Geikie, F.R.S., Mr. George Henry Hill, Mr. James Mansergh, and Dr. William Ogle, F.R.C.P.

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## Proposed Marine Biological Station in Jamaica.

The important results which have accrued from the establishment of marine biological stations, like those of Naples and Plymouth, in temperate regions, lead us to hail with pleasure the proposal to found a similar station in the West Indies. The scheme, which is connected with the approaching celebration of the fourth centenary of the discovery of America, has been ably advocated by Lady Blake, wife of the Governor of Jamaica, in a letter to the *Times*, and has already received cordial support from many of the most eminent men of science in this country, among whom Professor Huxley has emphasised its importance in another communication to the same journal.

It is proposed that the new establishment shall be called "The Columbus Marine Biological Station," and it is hoped that it will receive support not only from this side of the water, but likewise from our trans-Atlantic cousins. No such station yet exists anywhere within the tropics, and, judging from the accounts which have been given of explorations with the surface-net, and by other means, Jamaica seems to be one of the most favourable localities for such an institution that could possibly be chosen. As Professor Huxley observes, "Animal life is indescribably abundant and varied in the intertropical seas; but the mere fringe of it has, as yet, been skimmed

by naturalists under difficulties; literally cribbed, cabined, and confined on board ship, and at best unable to do more than collect and observe. Systematic investigation of the more difficult problems —for instance, those of development—which are of such vast importance to the modern biologist, has been out of the question." The report of Professor W. K. Brooks in the *Johns Hopkins University Circular* for February, alone suffices to show what success may be expected in Jamaica. With fourteen colleagues he spent last summer at Port Henderson, in Kingston Harbour, opposite Port Royal, and materials were obtained for many important researches. Among other novelties, Professor Brooks secured a good series of the successive stages in the development of the minute crustacean *Lucifer*, sufficient for the preparation of an elaborate memoir on the embryology of that interesting organism.

Lady Blake estimates the expense of the undertaking at £15,000, and such a sum ought surely to be raised with no great difficulty if the two English-speaking nations on both sides of the Atlantic will make a united effort to raise a monument worthy to commemorate the discoverer of the New World.

No definite details are given in Lady Blake's letter as to the precise plan on which the establishment is to be founded, although we presume from the estimate of the cost that these have been carefully thought out. In a third letter on the subject, Professor E. Ray Lankester calls attention to the need of such details, and lays especial stress on the necessity of an adequate scientific and working staff, as well as on the importance of having a good cruiser attached to the establishment. With these observations we cordially agree, although we venture to think that those who have had experience of a tropical climate will attach more importance to the need for good substantial buildings than he is inclined to give. We shall, however, doubtless soon be furnished with further information from Jamaica on these points as the scheme matures, and in the meantime we wish it every success.

## Field Clubs.

The spirit of Gilbert White and Darwin appears to be sadly on the wane among some of our British Field Clubs. There is plenty of vitality, it is true, in these admirable organisations, and they are all doing a good work by fostering the love of nature in their respective districts. Something more, however, is expected from the Field Clubs beyond the rousing of interest in the minds of those who would otherwise look upon Natural Science with apathy. Every club has a certain number of enthusiastic naturalists who devote all their leisure to the pursuit of their favourite studies; and this work results in many cases either in valuable collections or original papers, or in both. Sometimes the results are of so much interest and permanent

value, that the local worker eventually finds himself in constant communication with the leaders in that branch of science to which he gives attention, and his researches then become directed to the most profitable channels for further development; but in most instances there is an unfortunate want of aim and purpose in the work. Instead of making systematic observations or experiments, guided by the theories and partially established principles of modern science, the botanist or zoologist, confined to a limited area, is contented too frequently with poring over descriptive handbooks, identifying his captures, and then publishing endless lists and notes of "occurrences." There is a total absence of philosophy, and these lists and notes are only too often the melancholy signs of the approaching extinction of rare types of life at the hands of eager collectors or thoughtless "sportsmen." Notwithstanding the innumerable little treatises on animal life, practical biology, microscopy, zootomy, and practical botany, there is still room for some widely-gifted naturalist, or naturalists, to produce a book, or series of books, for the guidance of would-be observers. Modern problems ought to be stated in such terms that any ordinary student of nature, dwelling at a distance from towns and libraries, could turn his observations to some profitable account. The mere recording of "occurrences" might thus be replaced by valuable advances in our knowledge of the life-history of some of our commonest animals and plants, by the study of variations in accordance with surroundings, and also by many facts concerning what Semper terms the "Physiology of Organisms" at present almost ignored.

## Pre-Glacial Man in Britain.

The discussion of man's antiquity in Britain has, by common consent, been allowed to slumber for some years. It was felt that much of the evidence brought forward was scarcely such as to command the respect of geologists, and it seemed also probable that before long facts would be discovered that would definitely settle the question. The subject has now been re-opened through the publication of three papers by Professor Prestwich.[1] We are afraid, however, that many weak links exist in the chain of argument by which he attempts to prove that man existed in this country prior to the denudation of the Thames Valley and of the Weald. Neither geologists nor anthropologists will be quite prepared, without better evidence, to accept his conclusion "that not only was the plateau

[1] "On the Relation of the Westleton Shingle, &c. Part iii.—The Southern Drift." *Quart. Journ. Geol. Soc.*, vol. xlvi., p. 155 (1890).

"On the Age . . . of the Valley of the Darent . . ." *Ibid.*, vol. xlvii., p. 126 (1891).

"On the Primitive Characters of the Flint Implements of the Chalk Plateau of Kent, with reference to the question of their Glacial or Pre-Glacial Age." *Journ. Anthrop. Inst.*, vol. xxi., p. 246 (1892).

race not contemporary with the valley men, but also that the former belonged to a period considerably anterior to the latter—either an early Glacial or a pre-Glacial period."

The plateau race referred to by Professor Prestwich in the above quotation, is supposed to have manufactured certain extremely rude implements found at high levels on the Chalk Downs, near Sevenoaks. These implements are thought to be as old as the "plateau drift" which caps the higher part of the Downs. The plateau drift is considered to be older than the oldest of the river-terraces, and older than the Boulder Clay.

If all these statements are allowed to pass without question, no doubt man is pre-glacial in Britain; but, unfortunately, many of the supposed flakes yield but doubtful evidence of human agency, and none of them have yet been found more than $2\frac{1}{2}$ feet below the surface, though the Drift is said to be from 5 to 20 feet thick. At present, also, there is no evidence that the plateau drift, as we now see it, is in its original state; but it rather seems that, what with solution of the underlying Chalk, flood action, and other causes, it is almost impossible for the Drift to have remained undisturbed during a long period.

Professor Prestwich concludes that "the rude implements would appear to have been carried down, with the southern drift, on to the plateau, from those Central Wealden uplands which [he has] estimated might, in pre-glacial times, before the denudation of the Weald, have formed a low mountain range 2,000 to 3,000 feet in height." We should be inclined to doubt the existence, during any period, of such a mountain range, formed of soft strata like those of the Weald. Even granting the existence of this mountain chain, and of the floods which swept the Greensand material northward on to the Chalk plateau, it does not necessarily follow that the implements were transported in the same way, or are of contemporaneous date. They may be of much later date, and only accidentally associated with fragments of Greensand, such as may have been moved and re-deposited, time after time, before coming to rest in the now-existing red clay.

Professor Prestwich's earlier papers form a most valuable contribution towards a study of Palæolithic man and his tools, but we do not feel satisfied that in these latest memoirs he has advanced our knowledge of the antiquity of the human race in this country. The question still remains as it stood several years ago.

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## Two Zoological Fables.

In 1719, Leuwenhoek first started the idea that Rotifers, or "Wheel-animalcules," could be completely dried and kept for years in that condition, and then restored to life by being moistened with water. His conclusions were supported by Spallanzani in 1776

after a long series of experiments, and the theory of "palingenesis" passed into the rank of accepted truths: thus the name of *rediviva* was frequently applied to new species by authors who might be supposed to possess especial knowledge of the group. Hence it is not surprising that the idea that Rip-van-Winkledom was a normal condition of things among Rotifers should have gained widespread popularity, and have done duty as one of the principal articles of the stock-in-trade of successive generations of lecturers and writers on the romance of natural history.

So improbable a theory, however, was not allowed to pass unchallenged, and Pouchet, in 1859, subjected it to very severe adverse criticism. Frédéricq, in 1889, and Zaccharias a year later, also opposed it, while now Dr. F. Faggioli, of Genoa, has completely demonstrated the erroneous character of the whole story.[1] He has carried out a series of experiments conducted with the precise methods of modern research, and has shown that a Rotifer, if once properly dead or dried, cannot in any way be brought to life again. Dr. Faggioli has also pointed out the nature of the mistake made by earlier experimentalists: they had identified a new generation that had developed from eggs as the old generation again risen from the dead. It was found necessary always to dry the Rotifers on sand, preferably that from the tank in which the Rotifers grew. Dr. Faggioli has shown that the eggs are not destroyed by drying, and that when the experiments were successful, eggs must have been introduced with the sand or in the bodies of the Rotifers. On placing these eggs in suitable conditions development proceeds, and a new crop of Rotifers is the result.

There can be no doubt that the supposed recovery of the Water-Bears (Tardigrada) affirmed by Doyère, admits of the same simple explanation.

Another oft-quoted marvel that has recently been further exposed is the wonderful adaptability of the freshwater Polype, *Hydra*. It has long been said that if *Hydra* be turned inside out it accepts the situation, and lets its skin act as its stomach, and its stomach as its skin. This and many other antics were observed by Trembley, and described in a memoir issued in 1744; they were very widely believed in an age which knew little or nothing about the differences between ectoderm and endoderm, and which never troubled whether the spermatozooids were formed from the former or the latter, and which had never heard of mesoglæa. With the growth of knowledge of Hydroid anatomy, however, the story became discredited, and now some Japanese biologists have repeated the experiment, the results suggesting that Hydras have changed their habits rather than their skins, or that the worthy Abbé's observations were not as careful as they might have been. The Hydras may live for a little time under

[1] "De la prétendue réviviscence des Rotifères," *Archiv. ital. Biol.*, vol. xvi., pp. 360–374 (1891).

these altered conditions, but they make every effort to get right side out again; if this is impossible, a new formation of ectoderm takes place around the base of the tentacles, and may spread further over the animal. There seems no reason to believe that the endoderm ever functions as the ectoderm, or *vice versâ*, while the stories about the reproduction of Hydra from small parts have also been exaggerated.[1]

Hence, though it is very sad to have to part with two such old friends as the reversible Hydra and the resuscitated Rotifer, biology will gain more than it will lose by this substitution of common sense for paradox and puzzle.

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## Extinct Vertebrata in the Grecian Archipelago.

In a special chapter of a work on the natural productions of Samos,[2] Dr. Forsyth Major gives us further information on the wonderful extinct vertebrate fauna of that island which he himself has been the means of bringing to light. We are first told how the author was led to believe in the existence of such remains from passages occurring in the writings of Euphorion and Plutarch, and how he was finally rewarded by their discovery near the village of Mitylene. Dr. Major has determined the existence of over forty species of animals from these deposits, of which all but four are mammals. Many of these are common to the equivalent deposits of Pikermi in Attica, Baltavar in Hungary, and Maragha in Persia; and the relationship of the fauna to that of modern Africa is exemplified by the number of species of antelopes, by the occurrence of Ethiopian types of hyænas and rhinoceroses, and likewise by the occurrence of an ostrich and an aard-vark.

The most interesting of all the animals noticed by Dr. Major are those of which the teeth were originally described as referable to an ungulate (*Chalicotherium*), and the claws as those of an edentate. It is concluded that, although these animals present a most remarkable resemblance to some of the Odd-toed or Perissodactyle Ungulates in the structure of their teeth and limbs, yet that they have really no direct relationship, but represent a distinct order—Ancylopoda. The three-toed feet, with their enormous curved claws, differ from those of the Perissodactyles in that the middle toe is smaller than the others; while in their powers of prehension these limbs are, of course, quite unlike those of all modern Ungulates. Dr. Major considers that while the representative of these animals found at Samos and

[1] For the latest literature on this subject, see Engelmann, *Zool. Anzeiger*, vol. i., pp. 77–8 (1878); W. Marshall, *Zeitschr. für Wiss. Zool.*, vol. xxxvii., pp. 664–702, and especially p. 682 (1882). For an account of the experiments by Mitsikuri and others, see *American Naturalist*, vol. xxi., pp. 387–8 and 773 (1887).

[2] *Samos.—Etude géologique, paléontologique, et botanique*, by C. de Stefani, C. J. Forsyth Major, and W. Barbery. Lausanne, 1892. 4to.

Pikermi constitutes one genus (*Chalicotherium*), that from the somewhat lower beds of Sansan, in the Gers, must be referred to another (*Macrotherium*), distinguished by the structure of its foot.

When discussing the age of the Samos, Pikermi, and Maragha strata, the author refuses to admit the view of their Pliocene age, and continues to regard them as Miocene. We fail, however, to see how he has accounted for the presence of beds with marine Pliocene shells among and below the Pikermi strata, or for the alleged upward passage of those at Maragha into the Pleistocene. The author proceeds to consider the relations of these beds to the Siwaliks of Northern India, which he concludes to be somewhat newer, and more nearly related to the mammaliferous strata of the Val d'Arno, in Tuscany. We may, however, point out that the Siwaliks embrace an immense thickness of strata, which may represent the whole period during which both the Pikermi and Val d'Arno beds were deposited; and this would well harmonise with the occurrence in the Siwaliks both of the three-toed horses (*Hipparion*) of the former and the true horses of the latter beds. Moreover, in such correlations something must be allowed for zoological regions, which probably existed to a certain degree even in those early days.

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THE discovery of the extinct mammals of Samos, and of those of Maragha a few years previously, has largely increased our knowledge of the relations of the ancient vertebrate faunas of Europe and Asia; but a full exploration of Baluchistan is still required before we can obtain definite information as to the connection between the fauna of Maragha and the Siwalik fauna of the Punjab. Eastwards of India, the extension of the extinct mammals of the Siwaliks into the islands of the Malayan region and China has been gradually made known of late years, and a small collection of remains from Mongolia recently described by Mr. Lydekker (*Records Geol. Survey, India*, vol. xxiv., 1891, p. 207) now indicates that the same fauna ranged far into the heart of Central Asia.

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A FINE skull of the new variety of the extinct Irish Deer (*Cervus giganteus*, var. *ruffi*) is described and figured by Dr. A. Nehring in the *Deutsche Jäger-Zeitung* for February 7. This variety was first indicated in 1891 from a shed antler obtained near Kottbus in Brandenburg, and the new "find" was dredged from the Rhine near Worms. The peculiarity of this variety is that the antlers, instead of extending nearly horizontally outwards, are directed upwards like those of a fallow deer, and have a similar inclination of the plane of their expanded portion. Although they agree with the ordinary Irish deer in their palmated brow-tine, they indicate a decided approximation to the fallow deer type, this being especially shown by the

position of the posterior tine, which clearly represents that of the latter. Professor Nehring has some doubts whether this deer ought not to be regarded as a distinct species.

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An important contribution to the ancestral history of the Horse is afforded by Professor W. B. Scott's memoir on *Mesohippus* and *Leptomeryx* in the December number of the *Journal of Morphology* (vol. v., pp. 301-406, pls. xxii., xxiii.). *Mesohippus*, from the White River Miocene of the United States, was an animal about the size of a Newfoundland dog, and closely allied to *Anchitherium* of the Miocene of Europe. According to Professor Scott it was distinguished from the latter by the absence of any rudiment of the infolding of the crowns of the upper incisor teeth (comparable to that occurring in those of the horse), and by certain details in the structure of the other teeth and the limbs. *Mesohippus* is considered to have occupied a position near the middle of the ancestral "phylum" of the horse, while it is suggested that *Anchitherium* may have been a side branch.

The other animal described in the same memoir is *Leptomeryx*, which Dr. Scott regards as closely allied to the modern chevrotains, but showing certain resemblances in the form of the incisors and the auditory bullæ of the skull to the true Ruminants or Pecora. The latter features are, however, considered to have been independently acquired.

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In the last number of the *American Journal of Science* (vol. xliii., pp. 249-262, pls. v.-xi.) Professor O. C. Marsh gives a further instalment of his researches on the fossil mammals of the Laramie Cretaceous beds of the United States. It is considered that the fauna indicates a marked break between the Laramie Cretaceous and the Puerco, or Lower Wahsatch, Eocene beds. The mammalian remains obtained from the former are now very numerous, although, unfortunately, very fragmentary, consisting mostly of detached teeth. Professor Marsh describes a number of these specimens, of which many are regarded as indicating new species or genera. We consider this reckless multiplication of names much to be deplored, as there is little doubt that far too many species and genera have already been made upon the evidence of specimens from these deposits. That the number of so-called species and genera will eventually have to be reduced materially, Professor Marsh himself seems to have a suspicion, when he attempts to warn off criticism by saying that, in comparison with describing species on the evidence of imperfect specimens, "it is a matter of much less importance if such discoveries should prove that two or more specimens, described as distinct, really pertained to one animal."

A large proportion of the remains described belong to the group generally known as Multituberculata (Allotheria of Professor Marsh);

and it is stated that the new specimens serve to indicate more conclusively than hitherto the relationship of that group to the Monotremes, although this is not very apparent from the descriptions. The other remains belong to Marsupials, which are considered to be most nearly related to the living opossums.

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IT is not often that ordinary text-books are in advance of current thought, but Mr. Arthur Thomson's *Outlines of Zoology*, which we review elsewhere, contains one bold statement that we commend to the notice of those interested in the classification of vertebrated animals. The author remarks: "What the 'worms' are among Invertebrates, the Reptilia are among Vertebrates—an assemblage of classes." Unfortunately, nearly all the more important forms of reptiles are extinct, and they are thus known only by skeletons; but that they are a medley of widely distinct groups is becoming very evident. As shown more especially by the researches of Cope, Marsh, and Seeley, the early extinct "Reptilia" (including the Labyrinthodonts) form the base of at least four widely divergent lines of evolution—the modern Batrachia, the modern Reptilia, Birds, and Mammals. The formal dismemberment of the "class" may be only a question of time.

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ALTHOUGH known now for twenty years, it is remarkable how little information has been added to our knowledge of the Australian Mud-fish, *Ceratodus*, since its original description by Dr. Günther, and the subsequent notes by Professor Huxley. At the meeting of the Australasian Association in Hobart Town last January, Professor Baldwin Spencer returned to the subject, describing some of the habits of the animal; but, judging from the brief report to hand, he had little new to communicate. It is suggested that the lung-like air-bladder of *Ceratodus* is of special use to the fish at times of floods, when the water in which it dwells is charged with much sediment; and there is no evidence that *Ceratodus* ever leaves its native element, being in this respect unlike its African ally, *Protopterus*, which lives coiled up in a "cocoon" in dry mud during the hot season. It is of the greatest importance from the philosophical point of view that we should have some detailed memoirs on the embryology of *Ceratodus*, and to us it is inexplicable that none of the able biologists in Australasia have yet accomplished so important a research. Nearly ten years ago Mr. Caldwell, of Cambridge, made the collection of the embryos of *Ceratodus* one of the special objects of his mission to Australia, towards the expenses of which both the Royal Society and the University of Cambridge contributed funds; yet, so far as we are aware, there are at present no scientific results. Specimens collected at public expense ought to be public property, and if the naturalist who does this service loses his enthusiasm or undertakes

other duties that prevent the carrying out of his agreement, the material ought to be at once handed over to some competent colleague who will render it available to science.

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Of the extinct allies of the recent *Ceratodus* we have learned a little more during the last twenty years. In 1891, indeed, the greater part of the skull of the true Triassic *Ceratodus* was described in Austria[1]; and some years previously a tail had been found in the Upper Trias of Würtemberg. Teeth of the same genus have also been discovered in Western North America and South Africa. It now appears from Teller's memoir on the Austrian specimen, that, although the true *Ceratodus* of the Triassic period was very similar to the fish still living in Queensland, there are generic differences; and it is proposed that the recent fish should henceforth be termed *Epiceratodus*. The name *Neoceratodus* would have been more appropriate, but that has been already used for an ally in New Guinea. The fossil, so far as known, differs from the recent fish in the greater extent of the ossification of its skeleton.

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Speaking of the extinct Dipnoan Fishes, reminds us of the remarkable change in the ordinary conceptions of this sub-class that certain palæontologists are inclined to introduce. In the second part of the *Catalogue of the Fossil Fishes in the British Museum*, published last year, Mr. Smith Woodward hazarded the suggestion that in early Palæozoic times some of the tribes of Dipnoan fishes were as highly specialised in comparison with the *Ceratodus* type as are the modern Teleostei compared with the Fringe-finned Ganoids from which they are doubtless descended. In a new number of the *Proceedings of the United States National Museum* (vol. xiv., pp. 449-456) just received, Professor E. D. Cope describes the skull of the Devonian *Macropetalichthys*, and is in favour of the same theory. Indeed, so far as the facts are known, the race of Devonian armour-plated "ganoids," of which *Coccosteus*, *Homosteus*, and *Dinichthys* are the best preserved genera, have the cartilages of the upper jaw fused with the skull, and are comparable only with the Dipnoi in the arrangement of their head-shield and dentition. The supposition that the Dipnoan fishes attained to an extreme degree of specialisation at the time when they were a dominant type of life is quite in accordance with known laws; and the fact that none but the more generalised forms survived until later periods, is also what might have been expected. We await with interest further discoveries on the subject.

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Professor A. Giard has just published a brief account of a small turbot, in which the original bilateral symmetry of the fish is

[1] F. Teller, "Ueber den Schädel eines fossilen Dipnoers, *Ceratodus sturii*, sp. nov.," *Abhandl. k.k. geol. Reichsanst.*, vol. xv., pt. 3, 1891.

partially retained, the eye of the right side not having quite passed over the top of the head, and both sides of the body being pigmented (*Comptes rendus Soc. Biologie*, Jan. 16, 1892). The Professor concludes that the coloration of the upper exposed side in the flat-fishes is due to the direct action of the light, and arrives at some other interesting results which we hope to notice on a future occasion.

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For some years Dr. R. Blanchard (of 32 Rue du Luxembourg, Paris) has been occupied with the preparation of a *Monograph of the Hirudinea*. He has now almost completed the section on Gnathobdellidæ, and appeals for the help of naturalists and museums who can supply him with leeches of which the respective habitats are definitely known.

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The interesting new Crinoid from the Galapagos Islands, *Calamocrinus diomedæ*, has at last been fully described by Professor Alexander Agassiz (*Mem. Mus. Comp. Zool. Harvard*, vol. xvii., No. 2, 1892). The monograph, which has just arrived in England, enters very minutely into the structure of the skeletal system of this form, and also contains notes on the apical system and the homologies of Echinoderms generally. There are thirty-two plates, and rarely has any Crinoid had its hard parts so magnificently illustrated. Since, however, the author has given no diagnosis, no succinct description, and no synopsis of its relations to other genera, we must defer a fuller account of this remarkable form until we have digested the large mass of facts now published.

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A study of the nervous system of organisms so lowly in the scale of animal life as the Alcyonarian polypes (*e.g.*, the common "Dead-men's fingers" of our British coasts) presents many features of interest, and has just been undertaken by Dr. S. J. Hickson. At the meeting of the Cambridge Philosophical Society on February 22, Dr. Hickson communicated some preliminary results of his researches. In fresh specimens of *Alcyonium* stained with osmic acid, a plexus of very fine nerve-like fibrils, connected with a number of minute uni-, bi-, or tri-polar ganglion-cells, could be distinctly recognised in the dense, transparent gelatinous material between the several polypes of the colony. In their normal state the polypes of the *Alcyonium* contract regularly twice every twenty-four hours; and even when the colony is removed to an aquarium, where there are no tides, the regularity of the periods of contraction and expansion continues for two or three days. After such a period in an aquarium the polypes begin to remain expanded or contract only irregularly; but a new rhythm may be easily induced by subjecting the *Alcyonium* to the action of an artificial tide of any given duration. There is much analogy between this phenomenon and the opening and closing of flowers.

There are many advantages in comprehensive handbooks prepared by a single author. They present a uniformity of plan and treatment that is nearly always lacking in composite works. In these days of specialisation, however, the production of such handbooks is becoming almost impossible; and most of the larger treatises are the result of the labours of many compilers. According to the *Zoologischer Anzeiger* of February 1, another of these indispensable works of reference is being prepared, and we may hope within the next few years to have a great Manual of Zoology written by a number of the most eminent specialists in Europe. The respective authors desire that they may be promptly furnished with reprints of all new papers and memoirs relating to their various subjects, as enumerated below:—

Rhizopoda, Ciliata, and Suctoria—Dr. Fabre-Domerque, Paris. Sporozoa—Professor Moniez, Lille. Flagellata—Professor Künstler, Bordeaux. Porifera—Professor Vosmaer, Utrecht. Anthozoa—Professor Künstler. Hydrozoa, Siphonophora, Acephala, Ctenophora—Professor Lang, Zurich. Dicyemidæ—Professor Van Beneden, Liége. Orthonectidæ—Professor Julin, Liége. Trematoda, Cestoda—Professor Moniez. Turbellaria—Professor Lang. Rotifera, Gastrotricha—M. De Guerne, Paris. Archi-annelida, Sternaspida, Phoronida—Professor Roule, Toulouse. Hirudinea—Professor De Nabias, Bordeaux. Annelida—Professor Yung, Geneva. Bryozoa—Professor Cuénot, Nancy. Brachiopoda—Professor Joubin, Rennes. Mollusca—Professor Pelseneer, Ghent. Protracheata—Professor Vayssière, Marseilles. Nemathelminthea, Acanthocephala—Professor Köhler, Lyon. Nemertea, Chætognatha—Professor Joubin. Linguatulida, Tardigrada, Pycnogonida, Arachnida—Professor Barrois, Lille. Myriopoda, Insecta—Professor Vayssière. Crustacea—Professor Giard, Paris. Echinodermata—Professor Cuénot. Enteropneusta—Professor Köhler. Tunicata—Professor Van Beneden. Amphioxus, Cyclostomata—Professor Julin. Pisces, Amphibia, Reptilia, Aves—M. L. Dollo, Brussels. Mammalia (except Primates)—Professor Weber, Amsterdam. Primates, including Homo—Dr. Deniker, Paris.

Some time ago we heard rumours of a similar Manual projected at Cambridge, to be undertaken by British naturalists; but there is as yet no definite announcement.

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The supposed discovery of pseudopodia in diatoms, announced by Mr. J. G. Grenfell in the *Quarterly Journal of Microscopical Science* for October last, is still being disputed by experienced observers. In the January number of the *International Journal of Microscopy and Natural Science*, issued late last month, Mr. Jabez Hogg adds his testimony to that of other critics, and briefly disposes of the so-called evidence of "pseudopodia." Mr. Hogg confirms the view of Mr. G. H. Bryan that the processes in question "are, in no sense of the word, pseudopodia, neither are they, nor can they be, regarded as organs of locomotion; and their discovery—which, by the way, is a very aged one—throws no light whatever on the debatable question: the movements of diatoms. These spinous processes have been described over and over again. Their composition is simple enough: Organic matter, carbonate of lime, and a slight admixture of a silicated peroxide. They are apparently secreted by the diatom for the purpose of affording a rigid support to

the gelatinous or protoplasmatic material outside the framework or skeleton. Very many genera besides *Melosira* and *Cyclotella* are known to possess similar spinous processes, which are stiff, non-retractile, and arranged symmetrically around the valves. The same kind of perfectly rigid spines are also a characteristic formation of many desmids—*Micrasterias*, *Arthrodesmus*, *Epithemia*, *Stephanosia*, and *Achnanthidium*. These appendages, however, bear no resemblance to the well-known pseudopodia of the lower Protozoa, which are most undeniably organs of locomotion and prehension." Mr. Hogg continues with a readable review of the theories of the movement of diatoms, which we commend to the notice of all interested in the subject.

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THE *Journal of Botany* makes the welcome announcement that Messrs. J. Britten and G. S. Boulger are preparing to issue in separate form the Biographical Index of British and Irish Botanists, which has for several years been running through the journal and has lately been completed. The Index is to appear in June, and will extend to the end of 1891.

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A STUDY of the Speeton Clay and its Russian equivalents has led Professor A. Pavlow to publish a long memoir on the various forms assumed by the "guards" of Belemnites in the new number of the *Bulletin de la Société Impériale des Naturalistes de Moscou* (vol. for 1891, Nos. 2, 3). Many good figures and detailed descriptions of Cretaceous species are given, and the memoir concludes with some general observations on the classification of these fossils. The "guards" of Belemnites seem to be of much value to the stratigraphical geologist—"medals," as Mantell would term them—but it is to be regretted that they furnish so slight an idea of the characters and evolution of the cephalopods to which they originally belonged. We are glad to notice that our countryman, Mr. Lamplugh, is co-operating with Professor Pavlow in his researches.

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WE regret to learn from recent letters from Dr. J. W. Evans, the geologist with the Matto Grosso Expedition, that the party has just returned to Europe after a somewhat disappointing journey. This seems to have been mainly due to the action of one of the recent Governments of Brazil, which refused to ratify the concession made by the late Emperor. The district in which Dr. Evans spent most of his time was not a profitable locality geologically, consisting of enormous tracts of crystalline schists, clay slates, and sandstones; these have so far not yielded a single fossil, and igneous rocks are represented only by seams of ashes in the slates. A few bands of limestone were met with, but they are all unfossiliferous. The most interesting part of Dr. Evans' journey seems to have been an ascent of the

lower peak of Urucum, some 2,500 feet high. On the mountain there are massive deposits of pure pyrolusite. The richly fossiliferous Mesozoic Limestones of Bolivia and the Andes of Western La Plata do not seem to extend as far east as the southern part of Matto Grosso. Dr. Evans' fellow-traveller, Mr. Spencer Moore, has made a large collection of plants.

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At the meeting of the Zoological Society on March 1, Mr. Graham Kerr exhibited a series of lantern slides prepared from negatives taken during his ascent of the Pilcomayo River in the steamer, "Explorer." These gave a good representation of the various types of scenery met with during that ill-fated expedition, and especially of the salt desert where the steamer was finally abandoned. The most valuable part of Mr. Kerr's collections had to be left with the steamer, but, nevertheless, important additions were made to the knowledge of the fauna of the district.

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A list of the fossils at present known from Western Australia has been published by Mr. Harry P. Woodward, the Government Geologist, in his report for 1890 (issued at the close of 1891). It is interesting to find familiar European names among the Devonian, Carboniferous, and Jurassic species; of special interest, too, is the record from the Cambrian rocks of *Olenellus* and *Salterella*.

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The excessive rainfall during the early part of the present winter has caused the opening of numerous chasms or "swallow holes." These are found principally along the line where Tertiary clays overlap the chalk. Fortunately, in the southern counties, few houses happen to be situated exactly on the line where "swallows" are likely to occur. Thus far all the subsidences have taken place in woods or open fields.

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The *Mediterranean Naturalist*, a monthly journal of Natural Science, edited by Mr. J. H. Cooke, B.Sc., F.G.S., of St. Julians, Malta, does not appear to be so widely known in Britain as it deserves to be. The first part appeared on June 1, 1891, and the journal contains much matter concerning the Mediterranean region of very wide interest.

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We are glad to hear that the *American Naturalist*, of which no number has reached England since November, is to be revived almost immediately under the auspices of new publishers.

# I.

# Factors in the Evolution of the Mammalia.

AT the close of his valuable memoir "On the Osteology of *Mesohippus* and *Leptomeryx*" in the last number of the *Journal of Morphology* (Vol. v., No. 3) Dr. W. B. Scott, of Princeton College, New Jersey, devotes a section to a critical consideration of some of the factors in the evolution of the mammalia. Therein, at the outset, he expresses his dissent on general grounds from Dr. August Weismann's now familiar theory of the continuity of the germ-plasm, according to which it is impossible for any character or modification of structure acquired during the life of the parent organism to be transmitted to the offspring which that parent subsequently produces. Quoting from Mr. W. H. Dall, he says: "The contention of Weismann, that 'not a single fact hitherto brought forward can be accepted as proof' of the transmission of acquired characters . . . reminds one of the familiar statement of twenty years ago, that the Darwinians had not brought forward a single instance of the conversion of one species into another species. If the Dynamic Evolutionist brings forward an hypothesis which explains the facts of nature without violence to sound reasoning, that hypothesis is entitled to respect and consideration until some better one is proposed or some vitiating error detected in it."

The special object of Dr. Scott's discussion is to show that the careful examination of certain series of fossil mammals indicates clearly that the Dynamic theory, that is to say, the hypothesis of the inheritance of acquired modifications of structure due to the direct action of the environment, is more probable than the hypothesis of unaided Natural Selection; or, to state the contention in his own words, "that transformation, whether in the way of the addition of new parts or the reduction of those already present, acts just *as if* the direct action of the environment and the habits of the animal were the efficient cause of the change, and any explanation which excludes the direct action of such agencies is confronted by the difficulty of an immense number of the most striking coincidences."

The evidences in favour of this contention are briefly as follows:—

(1.) The changes which are observed to occur in the fossil mammals under consideration are carried out in exact accord with the mechanical exigencies of the case. New facets on the bones and new cusps on the teeth appear in definite ways and in definite places. In the structure of the carpus and tarsus, the bones which answer to

those in the wrist and ankle of man, "we find that in any given phylum [or series in direct descent] very definite lines of evolution are early established and closely adhered to, and the changes are just those called for by the operation of dynamical influences." Moreover, in the matter of modifications of tooth structure, in all cases known to the author, the new points appear in places where, at some stage, there is special abrasion.

(2.) The evidence afforded by the reduction and loss of structures supports that afforded by the growth and development of structures. Such loss and reduction is ascribed by Dr. Weismann to "panmixia," or the *cessation* of that selective process which raised them to a high level of perfection and efficiency, and, so long as it continues, keeps them there. When the selection ceases, those individuals which have these now useless structures poorly developed are no longer weeded out and, breeding with those individuals which have the structures well developed, lower step by step the standard of efficiency. To this explanation Dr. Scott dissents on general grounds; and, with respect to the special field of mammalian palæontology, he says: "When we turn to the series of fossils, and follow out the history of disappearing organs, we find little to support the theory of panmixia. The reduction is steady and sure, if slow, exhibiting, of course, a certain degree of individual variation, but not the fluctuations which we should naturally expect to find were panmixia alone the cause of the reduction. As a matter of fact, when examining an extensive series of fossils reaching through many horizons, it is difficult to escape the suspicion that individual variations are not the material with which Natural Selection works, so steadily does the series advance toward what seems almost like a predetermined goal."

(3.) While the development of useful structures and the loss or reduction of useless structures are thus in close accord with the mechanical conditions, there is no evidence of tentative trials and false starts before the proper line of development is hit upon. If variations in accordance with mechanical conditions were selected from among other variations, we should expect to find evidence of such other non-adaptive variations. These may, however, be sought for in vain. The development of the carpus and tarsus may be traced step by step in the equine series from *Hyracotherium* to *Equus*. We find a definite chain of adaptive modifications. Non-mechanical variations do not occur.

(4.) Under the influence of similar environing conditions similar modifications have been induced in parallel series of animals not closely related to each other by genetic affinity. Thus, in several different groups there appear suddenly and simultaneously (using these terms in their geological sense) prismatic or rootless molar teeth, with very complex enamel foldings, the valleys between the harder enamel ridges being filled with the softer "cement." This development of complex grinding teeth is found to be contemporaneous

with the great extension of grassy plains. It may, therefore, be correlated with this extension of grass lands; and we may infer that the complex grinding teeth arose as a consequence of a change of food-supply presented to the herbivorous mammals from a diet consisting of soft plants and leaves to a diet consisting mainly of siliceous grasses. "Now, what is the probability," asks Dr. Scott, "that such a series of changes in horses, rhinoceroses, pigs, ruminants, elephants, and other families, should be due primarily to the mingling of different hereditary tendencies, especially when it is remembered that none of the ancestors of these groups possessed any such teeth? Or can it be reasonably contended that such parallel variations are due to the direct action of the climatic or other environment upon the germ-plasm?"

According to Dr. Weismann, it must be remembered, variations arise in the main from the combinations of slightly differing developmental tendencies in the elements derived from the parents which unite to form the offspring. Nothing acquired during the life of either parent, or both parents, can affect the germinal or fertilising element. It is, therefore, a matter of chance whether any new variation shall be well-adapted to somewhat new conditions of life, or shall be ill-adapted to such new conditions; but the well-adapted survive, while the ill-adapted succumb. How is it, asks Dr. Scott, that we find only favourable adaptations? Where are the unfavourable adaptations that succumbed? And how comes it that in parallel series of animals similar favourable adaptations so constantly occur, if these similar favourable adaptations be not due to the direct influence of similar environing circumstances?

In a presidential address to the Bristol Naturalists' Society, I briefly considered the bearing and value of such palæontological evidence in the vexed question of "The Nature and Origin of Variations," and I ventured to express a doubt as to whether the evidence could be regarded as conclusive as to "use-inheritance," or the transmission to the offspring of modifications of structure acquired by the parents during their individual life-time. In criticising the position occupied by Dr. Scott and those whose views are in accordance with his, I thought that some stress might be laid on the imperfection of the geological record, and that the number of individuals in our palæontological collections was not sufficient to constitute a truly representative sample. Furthermore, I suggested that, on the hypothesis of selection, the individuals possessed of unfavourable, unadaptive modifications must have been weeded out in the early stages of life. In reply to such criticisms, Dr. Scott says "that the objection drawn from the imperfection of the geological record, and from the small number of individuals contained in the museums, can be allowed little weight. So far as several of the mammalian phyla are concerned, the number of missing links must be very small, the wonderful series of American freshwater

Tertiaries being in this respect quite unrivalled in the known world. Of the better known species, the collections already contain hundreds, and sometimes thousands, of individuals available for study [and by implication, I presume, *actually studied*]. If results obtained from such material point in one direction, it is surely most illogical to assume that specimens yet to be discovered will probably lead to opposite conclusions. The probabilities are all the other way. . . . That individuals in the early stages of life are uncommon as fossils is very far from being the case. They are abundantly represented in the collections, and show no more tendency to indeterminate variation than do the adults. But even were the young stages unknown, before their absence could be allowed weight as an objection, it would be necessary to show that such very slight changes were of 'elimination value.'"

It is not my intention here to urge again my previous criticism. Personally, I also am disposed to question whether such very slight changes would be of what I have termed "elimination value," that is, whether they would be fatal in life's competition; but the thorough-going believer in Natural Selection as the sole factor in evolution does not accept my "elimination value." He says *all* unfavourable variations, no matter how slight, are eliminated; and it is he that we have to convince. From his point of view, then, I am still somewhat doubtful whether the material already studied is sufficient to justify the assertion that unfavourable variations in the budding stage (*i.e.*, scarcely recognisable, or deemed of no consequence by the palæontologist, but readily picked out by the "ever-vigilant eye" of Natural Selection) do not occur.

Granting, however, that my criticism was ill-founded—and it should be remembered that I was criticising the view to which I myself lean—it seems to me probable that, on the selection hypothesis, determinate variations in the direction of mechanical adaptations would far outnumber other variations in other directions. Take the case of an organism which has in some way reached harmony with its environment. Slight variations occur in many directions, but these are bred out by intercrossing. It is as if a hundred pendulums were swinging just a little in many directions, but were at once damped down. Now, place such an organism in changed conditions. The swing of one or two of the pendulums is found advantageous; the organisms in which these two pendulums are swinging are selected: they mate together, and in their offspring while these two pendulums are by congenital inheritance kept a-swinging, the other 98 pendulums are rapidly damped down as before.

Let us suppose, then, that the variation of tooth structure, in a certain mechanically advantageous direction, be such a selected pendulum swing. That particular pendulum, swinging in that particular direction, will be the subject of selection. The other pendulums will still be damped down as before, and in that particular

pendulum variations from the particular direction will be similarly damped down. It will wobble a little, but its wobbling will be as nothing compared with the swing that is fostered by selection. In this case, then, selection will choose between the little more complexity that is advantageous and the little less complexity that is disadvantageous. The little less complexity will be eliminated, the little more complexity will survive. The little less and the little more, however, are in the same line of developmental swing. Hence, the variations discoverable in fossil mammals in which tooth-development along special lines is in progress, will, on the hypothesis of selection, be plus and minus along a given line; in other words, the variations will be determinate, and in the direction of special adaptive modifications.

Of course, we may believe—as those who hold the view that acquired characters are transmitted to offspring do believe—that individual use gives the pendulum an added push. But if the considerations above urged have any weight, we cannot prove this by a study of palæontological records. It must be proved, if proved at all, by some crucial experiment still to be devised.

Unquestionably the phenomena of parallelism on which Dr. Scott, as we have seen, lays stress, forces on the believer in Natural Selection as the sole known factor in evolution the assumption that in different groups similar congenital variations occur. In the language of our analogy, each of half a dozen different groups has among its hundred pendulums one which is swinging in such a way that the plane is parallel to that of the other five. Or in the case of prismatic and complex tooth-structure cited from M. Kowalevsky, horses, rhinoceroses, pigs, ruminants, elephants, and others are all ready to develop a certain general type of molar, when the extension of grassy plains renders such development of advantage. It is, however, of the essence of the Darwinian faith to believe that the whole organism is eminently plastic, and, according to Dr. Weismann's view, the ever-varying combinations of germ-plasm give unlimited possibilities of advance, retrogression, or divergence in the congenital modification of structure.

In conclusion, I may, perhaps, be allowed to say that in the general tendency of our opinions Dr. Scott and I are at one. Where we differ is in the estimate of the value of palæontological evidence. By itself, this does not seem to me to be sufficiently convincing or conclusive to win over a single follower of Dr. Weismann. If the transmission of acquired characters were demonstrated as an unquestionable fact, the Dynamic Theory would no doubt be generally accepted as a *vera causa* in the evolution of the Tertiary Mammalia of the North American Continent; but to one who denies the possibility of such transmission, all the facts brought forward by Dr. Scott will still be held to be explicable on the hypothesis of Natural Selection.

C. LLOYD MORGAN.

# II.

# Some Salient Points in the Study of Mammals during 1891.

(*Continued from page* 39.)

Passing on to fossil mammals, one of the most important and interesting memoirs published during the year relates to the extinct allies of the giraffe[1]—an animal which, as most of our readers are probably aware, now occupies a somewhat isolated position, being the sole representative of a distinct family. In the Pliocene epoch there appear, however, to have existed a number of ruminants more or less closely related to the giraffe, and it is the object of the memoir quoted to show that this relationship is even more intimate than had hitherto been considered to be the case.

Giraffes themselves, it need scarcely be observed, are now confined to Africa, but there is abundant evidence to show that they were formerly spread over Southern Europe, Persia, India, and China. One of their nearest extinct allies seems to be the *Samotherium*, from the Pliocene of the Isle of Samos and Persia, in which the males (Fig. 3) had short, upright horn cores, not improbably covered with skin in the living condition, while the females were hornless. In some respects, however, *Samotherium* shows decided signs of affinity with the Deer-family, as represented by the Elk; this being especially manifest by the equality in the length of the fore and hind limbs, and the comparatively straight profile of the middle part of the skull, and we thus have an interesting confirmation of the view which has been long current as to the kinship of the giraffe with the deer. Of especial interest is the proof afforded by this animal that a comparatively small ruminant from the Pliocene of Greece, known as *Palæotragus*, and hitherto regarded as an aberrant antelope, is also a near cousin of the giraffes, of which group it is the smallest known representative.

The connecting link between the Giraffe and the Samothere is formed by the well-known Helladothere, of the Grecian Pliocene, in which the fore limbs were longer than the hinder, while all the known examples of the skull were unprovided with antlers or horns, although the middle of its frontal region has a prominence corresponding to

[1] Forsyth-Major, *Proc. Zool Soc.*, 1891, pp. 315-326.

the so-called median horn of the giraffe. Perhaps, however, the most interesting portion of the whole memoir is that relating to the gigantic ruminants from the Pliocene of India, severally known as the *Sivatherium*, *Bramatherium* and *Hydaspitherium*. These creatures, which equalled a rhinoceros in bulk, were characterised by carrying large and branching appendages on their enormous skulls, which probably partook of the nature both of the antlers of the deer and of the horns of the oxen. There has been much discussion as to the affinity of these animals, some writers affiliating them with the antelopes, and others with the giraffe; but the author of the memoir before us so ably advocates the latter view that the question may now be regarded as finally decided. We may accordingly now look upon the giraffe as the last survivor of an extensive family of ruminants, which, after having included among its members the most gigantic representatives of the whole group, for some unknown reason suddenly disappeared

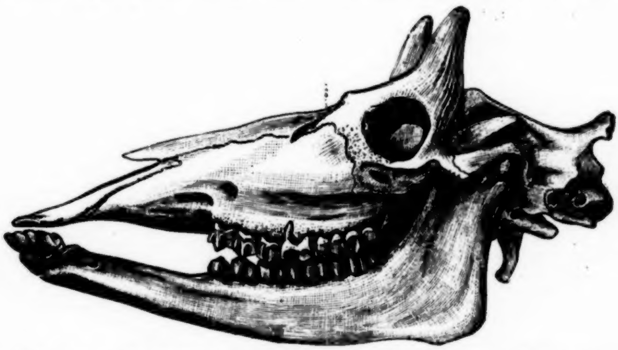


FIG. 3.—Side view of the skull of *Samotherium*. About ⅐ natural size. The horn-cores are provisionally restored.

from the face of the earth, with the exception of the one species which had obtained a footing on the African continent.

It is a far cry from the mountains of Northern India, where the remains of the Sivathere and its allies are entombed, to the pampas of the Argentine and Patagonia; but it is in the latter area where the next most important advances have been made in the palæontological history of the Ungulate Mammals. For these discoveries we are mainly indebted to Professor F. Ameghino, who has published the results of his observations in a serial[2] started during the past year. In these regions the extinct Ungulates seem to have run riot as regards strangeness of form and dissimilarity of structure to any of those found in the European area. Among the numerous types described in the various papers by Professor Ameghino, great interest attaches to the acquisition of the whole skeleton of an animal described some years ago by Professor Flower from the evidence of the

[2] *Revist. Argent. Hist. Nat.*, vol. i., 1891.

teeth and jaws alone under the name of *Homalodontotherium*. From the new discovery we now learn that this animal was a near ally of that peculiar aberrant Perissodactyle known since the date of Darwin's voyage as *Macrauchenia*. Very important information is also afforded as to the structure of those still more aberrant Ungulates known as *Nesodon*, which are nearly related to the huge *Toxodon*. It is now ascertained that the deciduous and permanent dentitions of these animals were very unlike one another; in consequence of which many species and even genera have been founded upon the remains of one and the same kind of creature. The most remarkable feature about the dentition of *Nesodon* is to be found in the circumstance that, while the first and second pairs of upper incisor teeth are very large and situated in the same transverse line, the third pair are small and placed in the antero-posterior line of the cheek-teeth, such a feature being quite unknown elsewhere among mammals.

We might go on almost indefinitely on the subject of these and other strange Ungulates from the Argentine, but we must pause to

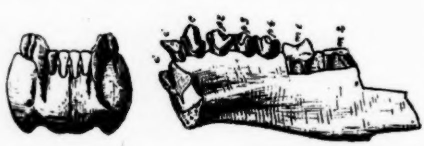


Fig. 4.—Front view of mandibular symphysis and inner side of right mandibular ramus of *Homunculus patagonicus*—natural size.

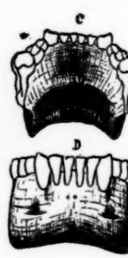



Fig. 5.—Inner (C) and front (D) views of mandibular symphysis of *Anthropops perfectus*—nat. size.

call attention to the great event of the year in the mammalian palæontology of these regions. Most of our readers are probably aware that, with the exception of the Opossums of America, the Marsupials are confined to Australia and some of the neighbouring islands. Hitherto, no fossil Marsupials of Australian types have been found in Tertiary deposits of any other parts of the world. Now, however, we have the discovery in the Lower Tertiaries of Patagonia of remains of Marsupials nearly allied to the carnivorous Thylacine of Tasmania, and the Dasyures which inhabit both that island and the Australian continent. These have been described under the names of *Amphiproviverra* and *Prothylacinus*.

This remarkable and unexpected discovery must profoundly modify the views hitherto obtaining as to the former distribution of Marsupials; and, taken in connection with other circumstances, seems indicative of a former more or less continuous land-connection between the southern extremities of America, Africa, and Australia. Not less important is the connection exhibited by these Patagonian Marsupials with the primitive Tertiary Carnivores of North America and Europe termed Creodonts; and this leads Dr. Ameghino to conclude that the

Marsupials, Creodonts, and true Carnivores are closely related. We may add that the asserted occurrence by MM. Moreno and Mercerat of a large Monotreme in the Patagonian Tertiaries will, if confirmed, strongly support the connection of the South American Tertiary fauna with the existing fauna of Australia.

Another very important event of the year is the discovery of numerous remains of small monkeys in the Lower Tertiary—? Eocene—of Patagonia, which have been described by Professor Ameghino[3] as *Homunculus*, *Anthropops*, *Homocentrus*, and *Eudiastatus*. The mandibles of these (Figs. 4 and 5) show the three premolar teeth characteristic of the American monkeys, and apparently belong to the family Cebidæ; they are remarkable for the extreme uprightness of the chin. If the Patagonian strata be rightly correlated with the European Eocene, we have now evidence of the existence of Anthropoid Primates at a much earlier date than has hitherto been

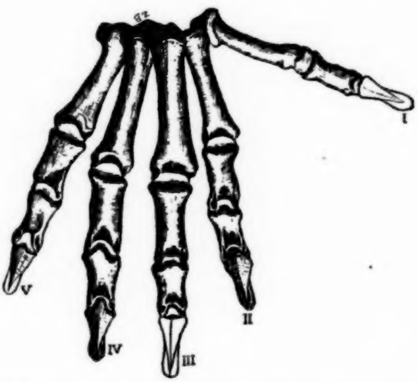



FIG. 6.—Skeleton of the right hind foot of *Icochilus robustus*—natural size.

recorded. Perhaps still more noteworthy are the signs of affinity exhibited by these early Primates to the extinct South American Protypotheriidæ. The latter are clearly related to the aberrant Ungulate *Typotherium* of the South American Tertiaries, which appears to be allied on the one hand to the extinct *Toxodon*, and on the other to the Rodents. *Protypotherium* and the allied *Icochilus* differ, however, by having all their teeth in contact, and by the terminal phalanges of the digits being expanded for flattened nails (Fig. 6) while both the thumb and great toe were opposable to the other digits. If substantiated, such an unexpected relationship as that of the American Primates to the Toxodonts will materially modify some of our present views as to the mutual relationships of mammals. We are indebted to Professor Ameghino for the figures of the remains of these monkeys and *Icochilus*.

[3] *Revist. Argent. Hist. Nat.*, vol. i., pp. 383-397, 1891.

We have yet another interesting discovery to chronicle before concluding our notice of the mammalian palæontology of South America. This relates to the remains of numerous small mammals presenting a more or less marked similarity to some found in the Secondary and Lower Eocene rocks of Europe and North America, and described as the Plagiaulacidæ. We may observe that these mammals (of which the Jurassic *Plagiaulax* and the Eocene *Neoplagiaulax* are well-known examples) are characterised by having a single large obliquely-grooved cutting tooth on either side of the lower jaw, which presents a considerable resemblance to the last lower premolar of the Rat-kangaroo (*Potorous*) of Australia, and also by having an equally large proclivous incisor on each side of the front of the same jaw. It was long considered that these Plagiaulacidæ were near allies of the kangaroos, but later observations have discredited this view, and have suggested that they were more nearly related to the Monotremes. Now, the South American forms (which have been imperfectly known to science for several years) also have a pair of procumbent incisors and a very large cutting premolar-like tooth in the lower jaw (Fig. 7) which may be vertically grooved; and it has

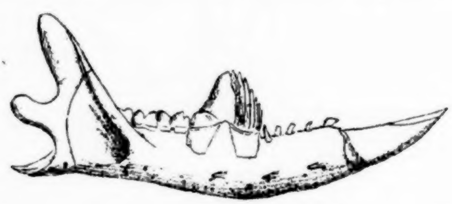


FIG. 7.—The right ramus of the mandible of *Abderites*, $\frac{5}{3}$ natural size.—After Ameghino.

accordingly been presumed that they were closely allied to the Plagiaulacidæ. The last-named tooth is, however, much larger in proportion to the others than is the case in the Plagiaulacidæ; while it is separated from the large incisor by five exceedingly minute, and evidently functionless teeth, which are very different from the two or three grooved premolars occupying the same position in the Plagiaulacidæ. Moreover, behind the large grooved tooth there are three molars, in lieu of the two of the latter. Dr. Ameghino considers that the large grooved tooth of these mammals, as represented by *Abderites* (Fig. 7), is the first molar, and not the fourth premolar; and he accordingly also regards the large secant tooth of the Plagiaulacidæ as a true molar. We are, however, by no means sure that the resemblance between the Abderitidæ and the Plagiaulacidæ is anything more than a superficial one; and, if this proves to be the case, the former family will indicate an entirely new group of mammals, of which the affinities cannot, at present, be even surmised. Whatever be the ultimate result, there can, however, be no sort of doubt as to the great interest attaching to these peculiar

South American mammals, which may some day, when their true affinities are known, afford important aid in constructing the table of mammalian genealogy.

That very similar structural peculiarities may arise separately in different groups is indicated by Dr. W. B. Scott's investigation into the phylogeny of the Camels and their allies;[4] where it is shown that the crescent-like (selenodont) grinding surfaces of the molar teeth of these animals have almost certainly been developed quite independently of those of the true Ruminants, which have a similar general structure. Indeed, it appears that we must go back as far as the small Eocene Ungulate known as *Dichobunus* (represented in North America by the closely allied, if not identical, *Homacodon*) before we reach what can be regarded as the common ancestral type of both the Camels and the true Ruminants.

That the evolution of the Camels took place in the New World has, for some years, been regarded as a fairly well ascertained fact, but it has been reserved for Dr. Scott to work out this phylogeny in a thoroughly satisfactory manner. It would be out of place to detail here the names of the various extinct genera connecting the modern Camels and Llamas with their primitive ancestral types; but we may observe that, as we descend the geological scale, we gradually find a less and less reduction in the number of the teeth below the normal type, accompanied by a steadily decreasing bodily size, till, in the American Miocene *Poëbrotherium*, we have an animal not much larger than a fox, with the full mammalian complement of teeth, and the metapodial bones of the feet not soldered together to form cannon-bones. Although this animal had acquired selenodont teeth, yet it is but a single step to a creature like *Dichobunus*, in which the molar teeth still retained the primitive hillock-like (bunodont) cusps of those of the pigs. Dr. Scott considers that towards the end of the Miocene epoch the ancestors of the modern Camels and Llamas respectively migrated to the Old World, and the southern half of the New; the earliest known Old World Camels being those of Northern India, which retain certain signs of kinship with the Llamas, which are lost in the living species.

The above appear to us to be some of the more striking results of the year's work in mammalogy; but there are, of course, many other topics of nearly or quite equal interest, which we are debarred from noticing by the necessary limits of our article.

R. Lydekker.

[4] On the Osteology of *Poëbrotherium;* a contribution to the Phylogeny of the Tylopoda. *Journ. Morphol.*, vol. v., pp. 1–78, pls. i.–iii., 1891.

# III.

## The Physical Features and Geology of Borneo.[1]

FROM the day when the companions of the ill-fated Magellan cast anchor before Brunei, in the early part of the sixteenth century, down to the present time, the island of Borneo has ever provoked a lively curiosity, and has been the subject of the wildest speculation. Its vast size and symmetrical position on the equatorial line early attracted the attention of geographers; but the exploration of the interior was long hindered by the trade policy of its first settlers, the Dutch East India Company, who deemed it expedient to confine their operations to the coast.

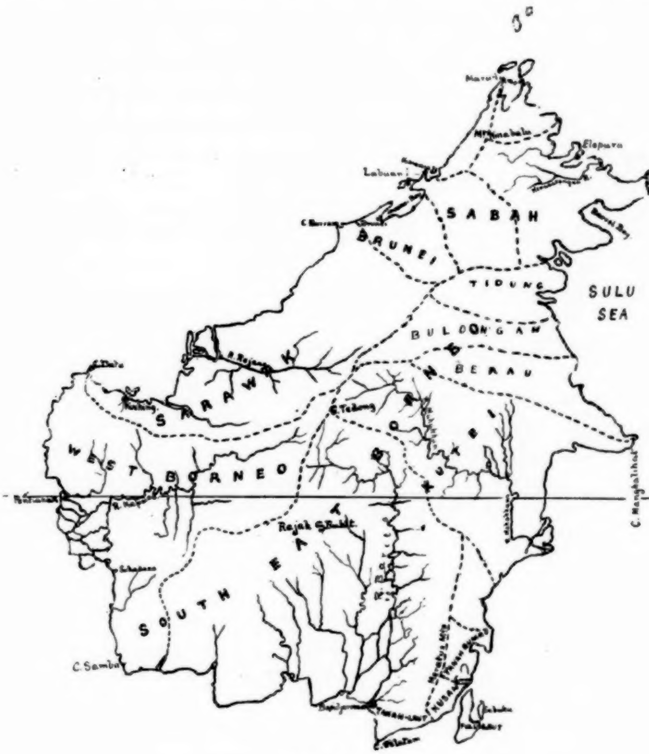
In more recent years, the popular imagination has been kindled by the romantic history of Sir James Brooke. That daring Englishman, arriving off the northern coast of Borneo, partly in search of adventure, partly with the idea of suppressing the Malay pirates who infested those seas, found himself, at the end of a few exciting years, installed as Rajah of Sarawak and ruler of a turbulent crowd of Malays, Dyaks, and Chinese. Strange rumours have also reached us of the ferocity of the head-hunting and cannibal tribes who share the forests of the interior with the orang-outang.[2] Lastly, the enterprise of the capitalist and the energies of the prospector have been stimulated by exaggerated reports of the wealth of the island in minerals and coal, of its wide-spreading gold-fields, and of its diamonds of fabulous size and unparalleled lustre. And yet, in spite of these manifold sources of interest, there is hardly another country of equal magnitude of which we know so little. It is true that the naturalist Wallace, in his "Malay Archipelago," draws a charming picture of the life and vegetation of the dense tropical forests of the island; but of its physical features we have, till recently, been in complete ignorance.

The vacuity of our knowledge of Borneo appears the more remarkable when we contrast it with the exactitude and minuteness of our information with regard to the neighbouring islands of Sumatra and Java; but the explanation is not far to seek. This is embraced in

[1] For the facts on which this essay is based, I have mainly relied on Dr. Theodor Posewitz's "Borneo" (Berlin: Friedländer und Sohn, 1889). I have recently translated this invaluable work, in which the whole of the literature (principally Dutch) has been admirably summarised; and it is with considerable satisfaction that I am able to announce the approaching publication of the English edition.—F. H. H.

[2] *See* Carl Bock's "Head-hunters of Borneo." London: 1881.

the physical and political conditions of the countries. The attenuated shape of Sumatra and Java makes it impossible to travel to any considerable distance from the coast; and they have been for many years under European rule. The configuration of Borneo is quite different. Its compact and rounded form measures 675 geographical miles, both from north to south and from east to west; while only the margin of its enormous area (219,034 square geographical miles)




Map of Borneo.

has been brought under the complete dominion of the Dutch and English.

The island has been traversed from coast to coast on more than one occasion by intrepid travellers, who, following one or other of the great rivers to its source, crossed the dividing range into the basin of another stream, which ultimately led them to the coast. But the main portion of the interior has remained, and, to a large extent, still is a *terra incognita*. The difficulties of transport through impenetrable forests, and over high mountain ranges, and the dangers to be apprehended from the hostility of the native tribes,

have combined to deter the scientific investigator from venturing far into the unknown and inhospitable regions of the interior.

In those districts where European settlements have long existed, for instance, in the districts of Bandjermassin and Tanah Laut in the south-eastern portion of the island, more exact details respecting its physical and geological structure have been obtained, for in these districts the country has been carefully examined in the eager search for useful minerals.

Much of the knowledge thus accumulated in the Dutch part of the island is due to the labours of the Natural History Commission, a scientific institution established in Batavia in the year 1820. Its members were scientific men, comprising, in the first instance, a zoologist, a botanist, and a geologist; and they were appointed for the purpose of investigating the resources of the as yet almost unknown island. At a later period, the geology of some portions of the island was elucidated by the work of the Batavian mining engineers, who were sent by the Dutch Government to search for useful minerals and for coal.

On the northern coast, our knowledge has received its greatest increment in Sarawak, by explorations carried on at the instigation of Rajah Brooke and his successor, Charles Johnson Brooke, and in Sabah, where the British rule has been inaugurated by the exertions of the North Borneo Company. Since 1881, when the company acquired its charter, our geographical and geological information of this part of the island has increased with every year. A band of courageous pioneers and explorers, defying every danger, have traversed these unknown regions in all directions, and scientific results of great value have been thus obtained.

## Physical Features.

Proceeding from an elevated area in the centre, the radiating lines of water-parting divide the island into a southern, a northern, a western, and an eastern catchment-basin. The divides, however, are not, as usually represented on the maps, formed by continuous mountain chains, but consist of a series of short ranges and abrupt ridges, or of isolated groups of mountains and single peaks, which are turned in the same general direction. Surrounding the mountains is a low undulating country in which the separate and outlying masses lie like islands in a sea.

This structure is the dominant feature of the orographic systems of Borneo, and is cleverly epitomised by Posewitz when he names the detached portions of the high land "mountain-islands." The gently rolling country which laps round the foot of the "mountain-land" he describes as "hill-land." The hill-land, in its turn, is bordered by dry plains which are often of great extent, especially in South Borneo; and these, again, pass into the swamps and morasses of the coast. Like the mountain-land, the hill-land sends

out spurs into the plains, and tongues of the latter extend into the marshes.

According to Schwaner, the central mountain tract has a north-east and south-west strike, and culminates in two high peaks—the Gunong Tebang and Gunong Apo Borau, estimated at from 5,000 to 6,000 feet high. The four chief ranges that branch off from this *massif* extend towards the south-east, south-west, north-west and north-east, and constitute the chief political boundaries.

The south-eastern chain has a varied character. Its central portion consists principally of hill-land through which only isolated peaks (mountain-islands) project; but its northern and southern parts are more ruggedly developed, and steep ridges and rocky peaks rise to a considerable height. The southern limit of this chain is formed (in Tanah Laut) by the Meratus mountains, the highest peak of which is 4,250 feet above the sea-level.

The south-western chain extends from the central tract to near Cape Sambar, which is the extreme south-western point of the island. With the exception of a few hilly tracts in its central part, this chain retains throughout a rugged Alpine character. Its highest point is reached in the Rajah Bukit—the Olympus of the Dyaks—which is a peak of 7,000 to 8,000 feet. Schwaner describes a portion of the chain as consisting of a high plateau, 20 to 30 miles wide, the surface of which is broken by numerous dispersed peaks.

The northern chain, which comprises a north-eastern and a north-western branch, is less known than the southern chains. Its highest part is reached at its northern limit in the imposing *massif* of Kina-balu (13,698 feet); in its middle portion the peaks vary from 6,000 to 8,000 feet, and still further west, between Sarawak and West Borneo, they decrease to 2,000—3,000 feet. The western branch of the chain terminates in the Datu Mountains, spurs of which reach the sea, forming the promontories of Api and Datu. Isolated peaks of this part of the chain have an altitude of 6,000 feet.

In their general character, the northern chains are similar to the south-western chain, being composed of detached ridges and mountain-islands. Kina-balu is the highest mountain in Borneo, and is held in much veneration by the natives. This fine mass is situated in the territory of the British North Borneo Company, and forms a striking feature in the scenery of this part of Borneo. It consists of about ten peaks in a line, running east and west, while a solitary peak rises on the south, separated from the others by a deep and wide ravine. Several of its peaks have been ascended by English explorers. Spenser St. John describes the view from one of the summits as magnificent: the coast-line of North Borneo is visible as far as the island of Labuan, while to the south and south-east the eye ranges over a multitude of ridges and peaks of from 7,000 to 8,000 feet.

In the central mountains rise all the principal rivers—the

Barito, which flows towards the south, the Kapuas to the west, the Rejang to the north, and the Mahakkam to the east. The Barito is 570 miles long, according to Schwaner. Besides these large rivers, there is a great number of smaller streams, which rise in the different mountain chains.

The rivers of Borneo pass through three distinct phases in their passage from the mountains to the sea. In an *upper course* they rush over a rocky bed with cataracts and rapidly shifting pebble islands. The *middle course* is through a more level country, in which the stream is often replaced by a string of lakes. The extent of these lakes depends on the time of year; during the rainy season the surrounding forests are often flooded for miles, while in the dry season they partially dry up, leaving a black fertile land, dotted with small patches of water. Such, for instance, is the case in the rivers Barito and Kapuas, both of which have an extended lake district. Another feature of this part of the course is the formation of natural canals (*antassan*) which cut across the loops. Similar natural canals (*trussan*) connect neighbouring rivers with one another. They are formed by the floods that arise during the west monsoon, and are very serviceable as water-routes to the traveller.

In the *lower course*, the river winds slowly through a flat swampy country, fringed with mangroves, nipa-palms, and other tangled jungle growth. This lagoon district is inundated daily at high water, and is covered for months during the rains. On retreating, the subsiding waters leave behind a black mud, rich in humus and full of shells. A large amount of this mud is brought down by the rivers. Its accumulation causes the formation of numerous mud islands. Occasionally the accumulation takes place in such a manner as to form a natural embankment, through which the river flows at a higher level than the surrounding marsh-land. A part of the sediment is carried out to sea, where it is deposited in banks which often constitute dangerous bars across the mouths of the rivers. On the east coast there are mud banks extending for 8—10 nautical miles into the sea: even at a distance of 10 miles the sounding line only gives a depth of 33 feet.

The deposition of sedimentary material brought down by the rivers, protected in some cases by the presence of coral-reefs, causes a rapid extension of the coast. This is aided by the growth of the jungle vegetation. On the newly-formed marsh-land mangroves soon spring up, and by their pendent air-roots favour the accumulation of the mud. The forward movement of the mangrove woods has been estimated to amount to be more than a hundred metres in forty years. Another jungle tree which acts in a similar manner is the nipa-palm. Flourishing alike in salt or fresh water, its matted roots serve admirably to retain the flotsam of the rivers; and it is propagated rapidly by its angular fruit, which, on falling, sinks easily into the soft mud. On the coast of Sarawak the annual increase is estimated at

15—18 feet. The formation of new land is further aided in South Borneo (Tanah Laut) by the deposition of the fine mud brought down by the river flowing through the gold-washing districts.

## Geology.

Posewitz treats the geology of the island under four principal heads:—(1) The mountain-land; (2) the Tertiary hill-land; (3) the diluvium, or drift of the plains; (4) the alluvium of the marshes.

The mountain-land consists partly of crystalline schists, with which old eruptive rocks (granites, diorites, gabbros, and serpentines) are associated, partly of a slate-formation which appears to be of Devonian age. So little is known of the geology of the mountain-land, that the schists have not been separated from the slates, and even the Devonian age of the latter is only problematical. The slate-formation comprises phyllites, sandstones, conglomerates, and quartzites. The Devonian (?) rocks are in places overlain by a Carboniferous formation consisting of a hard bluish limestone (Carboniferous Limestone[3]), succeeded by coarse white sandstones. This Carboniferous formation is largely developed in North Borneo, where it appears to extend from Sarawak to the Bay of Marudu. It has not been separated from the underlying slates, but is clearly marked off from the Tertiary beds that succeed it.

The presence of Cretaceous rocks in Borneo has been proved by the discovery by Van Schelle, in West Borneo, of fossils which have been referred by Geinitz to the Upper Chalk. This is the first recognition of the presence of Mesozoic rocks in the Indian Archipelago. How far they extend is at present unknown, but recent researches of Martin[4] appear to show that rocks of this age have a wide range in Borneo.

The Tertiary hill-land forms a broad belt round the mountain-land. It consists of a gently rolling country, which near the mountain border rises into hills of 200—300 feet (Eocene), but elsewhere dies away into the common level of the plains (Miocene).

Verbeek divides the Eocene of Borneo into three stages, namely: α, the sandstone stage; β, the marl stage; and γ, the limestone stage.

The sandstone stage (α) is the lowest, and, from a practical point of view, the most important, since it contains the Borneo black coal. It consists of alternating beds of sandstone shales, carbonaceous shales, and coal-seams.

The marl stage (β) comprises shales and marls, some of which are very fossiliferous, containing numerous remains of Crustaceans. One whitish-grey bed of marly limestone is packed with Orbitoides and Nummulites.

[3] Tenison Woods has described the following fossils, derived from this formation in Sarawak: a *Vertebraria*, *Phyllotheca australis*, a *Fenestella*, and a *Stenopora*.

[4] See *Nature*, 1889, p. 121.

The limestone stage ($\gamma$) consists of a hard white or bluish limestone, containing numerous fossils (Corals, Sea-urchins, Lamellibranchs, Gasteropods, Orbitoides and Nummulites). This stage appears to be the equivalent of the Nummulitic Limestone of Europe.

Schwaner describes it in the following terms: "The limestones possess the undoubted characteristics of a littoral formation: they consist of enormous aggregates of coral and broken shells, intermingled with the spines of echinoderms; and resting on a bed of hard rock, they follow the boundaries of the high ground, into its bay-like inlets and round its projecting promontories."

Space does not permit me to give details as to the development and distribution of these important Eocene deposits, nor to describe their fauna and flora.[5] Suffice it to say that stage $\alpha$ has been found to reach a thickness of 524 feet; stage $\beta$, to 820 feet; and stage $\gamma$, to 295 feet. With regard to the fauna, eighteen species of Gasteropods have been determined, all of which are marine types. They indicate a tropical climate, the majority of the species having their nearest representatives in the present fauna of the Indian Archipelago. The Lamellibranchs are better represented than the Gasteropods, and comprise an abundance of characteristic marine forms, indicating both deep and shallow seas. The Nummulites belong to four different species, two of which are peculiar to Borneo (*N. pengaronensis*, Verb.; *N. sub-brongniarti*, Verb.; *N. biaritzensis*, d'Arch.; *N. striata*, d'Orb. var.). The coral fauna of the Nummulite beds consist of species peculiar to Borneo (belonging to the Turbinolidæ, Stylophorinæ, Astræidæ, Madreporidæ, and the Poritidæ) and are of a reef-forming type. The flora has an Indian character, showing a remarkable resemblance to types now living in the East Indies.[6]

The Eocene strata have been pierced in numerous places by the eruption of andesitic lavas. These lavas are bedded, and are accompanied by tuffs. Since they have broken through the highest beds of the limestone stage, they are probably of Miocene age. Above the andesites lies a series of shales and sandstones, which Verbeek describes as Late Tertiary (Miocene). The lower beds consist of soft shales and harder marls. The greenish sandstones which lie above them have, in great measure, derived their material from the andesites and tuff. These Miocene beds contain occasional seams of brown coal, which is very inferior as fuel to the black coal of the Eocene beds.

[5] An admirable summary, with full reference to the literature, will be found in Posewitz's "Borneo."

[6] "The vegetation of the Sunda Islands has retained its Indian character, from the Eocene period down to the present time, although the Tertiary floras of Europe have been considerably modified." Geyler, *Jaarb. v. h. Mynwezen in Nederl.-Ind.* 1879. II.

The diluvium (drift) of the plains occurs chiefly as a zone round the Tertiary hill-land, though it also covers the flanks of the mountains. It is of great practical importance, as it contains the chief deposits of gold, platinum, and diamonds. It may be described as solid flat land in contradistinction to the marsh-, hill-, and mountain-land. Its composition is fairly uniform, its upper part consisting of clays and sandy clays, its lower of pebble beds. It is between the pebbles of the latter that the precious metals and stones are found, mixed with a fine clayey earth. In some places the pebbles are united by a siliceous cement to a hard conglomerate.

The alluvium of the marshes has a wide distribution in Borneo. Its mode of occurrence has been already referred to. The marsh-land rises very slowly from the coast. This is shown in the lower course of the rivers by the great distance from the mouth at which the influence of the tides is still perceptible. The Barito, for instance, is tidal for fifteen geographical miles, while in certain seasons the influence of the tides may be observed at a distance of thirty-five geographical miles. It is also shown by the immense area covered by the diurnal and periodic floods. The area flooded daily in the basin of the Barito is estimated by Schwaner at 160 square geographical miles, or one-twelfth of the whole river-basin, to which 420 square miles must be added in the rainy season. Consequently, during the west monsoon, 580 square geographical miles, or more than one-third of the river basin, are under water.

With regard to the geological evolution of Borneo, Posewitz's ideas are not altogether in unison with those that have been expressed by Wallace in respect to the whole of the Malay Archipelago. While Wallace regards these islands as having been produced by the breaking up of a continental area, Posewitz describes Borneo as resulting from the fusion of an archipelago of small islands. The grouping of the different island-clusters in this archipelago has been preserved in the main features of the present structure. A narrow island, which extended from north-east to south-west, is now the Tanah Laut range. Parallel to it was the mountainous island of Pulu Laut. The Pramassan Alai and Amandit mountains were represented by islands of the same general type. To the north there extended a broad sea, lapping round the foot of the central mountains. A few peaks rose from its surface, marking the direction of the south-east mountain chain. In the south-west was a large cluster of small islands, which are now the mountains of Sukadana and South-West Borneo. A large island occupied the position of the present Chinese districts, and from it a chain of islands extended to the great mass of Kina-balu in the north-east point of Borneo.

In the beginning of the Tertiary period the seas surrounding these islands began to be filled in by the deposition of sedimentary matter. Borneo now acquired a shape resembling that of the neighbouring island of Celebes. Great gulfs and arms of the sea, fringed

by coral reefs, occupied the place of the low-lying plains of the Borneo of to-day.

At the close of the Tertiary period, the gulfs gave way slowly to dry land; the seas became shallower and retreated, thus preparing the way for the advent of the present period. Numerous and powerful streams carved out a passage from the mountains and flowed towards the retiring seas, bringing with them their quota of mud and fine sand with which to increase the extent of the growing island. Thenceforth, down to the present time, no important changes have modified the physical features of Borneo; and the island has enjoyed a remarkable immunity from the fierce paroxysms of volcanic activity that, during the Recent period, have convulsed the other large islands of the Malay Archipelago, and culminated, in the year 1883, in the extraordinary outburst of Krakatoa.

F. H. Hatch.

IV.

# Great Lakes.

MUCH has been written on the origin of lakes, and on the character of their inhabitants; but the literature of the subject is buried in so many monographs and scattered papers that it may be useful to linger for a moment to review the present state of our knowledge. Especially is this advisable when we bear in mind the rapid advance in geographical and geological exploration which has taken place in the past decade. It should also be remembered that no one branch of Natural Science can stand alone; each in turn can aid and advance the others. If we wish to understand the fauna and flora which inhabit a lake, it is necessary to learn how that lake originated, and what was the date of its origin. The inhabitants of each existing lake do not include merely such plants and animals as, reasoning from analogy, we should say were most fitted for it. They are always mingled with certain forms which bring before one's mind the bygone history of the lake. The peculiar species may be allied to forms usually confined to salt water; or they may be species incapable of migrating across barriers of land, though now found in several distinct basins. We may find lingering in the depths of certain lakes species which point to extensive climatic changes since the lakes were first inhabited. This evidence of climatic change may also help us to understand why certain species are present, and others, seemingly equally fitted to inhabit the lake, are now absent.

Even a small lake must be studied from many points of view, if we wish to obtain anything beyond the merest catalogue of its inhabitants. Still more is this necessary when we deal with the vast sheets of fresh water which are found in the interior of our continents; for they, like the large oceanic islands, may contain lingerers of antique types, now lost in regions less isolated. We will attempt, therefore, in the following pages to show how lakes originate; and we will give, also, a short description of the great lakes now existing. It must be pointed out, however, that we know little as yet about the origin of great lakes, and the natural history of the most important group is still practically unknown. These notes were partly written to point out this deficiency in our knowledge, and if they help to stir up naturalists to a more thorough study of the Great Lakes of Central Africa, one of their principal ends will be attained.

The regions occupied at the present day by great freshwater lakes

are only two. There is the Central African region, with Victoria Nyanza and other equatorial sheets; and there is the somewhat similar cluster in North America, including Lake Superior. Another group once occupied most of the Mediterranean region and extended far into Asia; it is now represented by the Caspian Sea and other more or less isolated sheets of brackish water, but the western part has again become connected with the ocean and has lost its peculiar fauna. A fourth district to which we shall refer is now the arid region, or Great Basin, of North America.[1] This country was occupied not long since, geologically speaking, by magnificent inland seas, which now are represented by a few shrunken and saline remnants, such as the Great Salt Lake. No doubt other extensive lakes can be recognised by studying earlier geological history, but our present purpose is not to trace the former recurrence of lacustrine conditions; it is rather to study the history of the two great groups of freshwater lakes which still exist.

It is evident that, for the purpose of study, it will be most convenient to select lakes which still remain, but which formerly had a greater extent, and have thus left their ancient history written in the marginal sediments now accessible to our exploration. The two regions which most thoroughly answer to these conditions have been carefully studied, and they represent two distinct types. The Mediterranean has been alternately connected with the ocean or converted into a chain of brackish-water lakes. The Great Basin of North America, on the other hand, has contained lakes changing often in size, sometimes becoming almost dried up, sometimes filled to overflowing, but never forming part of the ocean. Thus we find that the lakes of the Mediterranean basin, even when nearly fresh, contain seals and other marine animals; while the Great Basin is characterised, and apparently always has been characterised, by the poverty of its fauna and the absence of marine forms.

Let us now trace the past history of these two continental basins, as far as our knowledge will permit us. We shall then be in a position to understand the probable mode of origin of the great lakes of Africa and America. We shall then also be able to realise the bygone conditions which led to the formation of such vast sheets of fresh water, and to their peopling with the animals and plants that now inhabit them.

In the long-settled and carefully-studied region between Europe and Africa, we find, at the present day, the western part occupied by the extensive inland sea, known as the Mediterranean. To the east, this is connected with other seas somewhat less salt, known as the Black Sea and the Sea of Azov. Still further east we find the isolated Caspian Sea and Sea of Aral. There may not appear at

[1] The maps illustrating this paper are all drawn to the same scale, so as to indicate the relative importance of the Basins. The figures on the lakes show the height of their surface above the sea.

first sight to be any resemblance between the isolated lakes and seas of western Asia and the Mediterranean; but when we trace back the geological history of the basin to early Pliocene times we meet with quite different conditions. The commencement of the Pliocene period was heralded in the Old World by the formation of brackish-water lakes on a scale unknown at the present day. *Congeria*-beds—so called from the numerous species of the brackish-water mollusc *Congeria* (or *Dreissena*) found in them—extend from Spain eastward into Asia. They are the deposits of the large lakes which in early Pliocene times seem to have occupied most of the Mediterranean basin. The Mediterranean does not seem ever to have formed a single great lake, for at various times during the Tertiary period there was apparently a connection between Europe and Africa, not only at the Strait of Gibraltar, but also across the ridge near Sicily and Malta.

If the movement which transformed the Miocene sea of the Mediterranean basin into a chain of brackish-water lakes had continued, and the barriers at the Strait of Gibraltar and the Isthmus of Suez had remained unbroken, we should have expected the lakes gradually to become smaller and smaller and more and more salt, as long as the inflow was less than the evaporation. But if the rainfall and inflow from rivers exceeded the evaporation, the lakes must increase, and find outlet across the barrier. Thus the sea would become gradually transformed into a series of freshwater lakes, like those of Central Africa. As far, however, as we can judge, the Mediterranean never reached this last stage, for after long ages of brackish-water conditions, and the differentiation of a certain number of peculiar species, the sea again broke in, and a copious marine fauna re-conquered its ancient territory. Thus the Mediterranean region is occupied by basins which may at any time easily be transformed into large freshwater lakes, though, as it happens, the sea has broken in on several occasions when the lakes were gradually forming. The continuity of the process was thereby stopped before the great sheets had become thoroughly fresh, and before a large lacustrine fauna had appeared.

Turning now to the second region of extinct lakes to which we have alluded, we find in the Great Basin of North America a district of which the geology has been worked out quite recently by the Geological Survey of the United States. It would be impossible in a few words to do justice to the valuable monographs by Messrs. G. K. Gilbert and I. C. Russell, but their main conclusions are these. An enormous area in Nevada, Utah, Oregon, and California forms an enclosed basin, now occupied by deserts and by salt lakes with no outlet towards the sea. The basin seems to have originated in late Tertiary times, through irregular earth movements which raised certain tracts and depressed others. The region was apparently altogether above the sea-level when the formation of the

basin took place, or at any rate was saved from the influx of the sea by higher land. We find, therefore, no evidence that the sea ever penetrated into the region after it became a basin, and there is no evidence of the former existence within it of a marine fauna.

Though the sea never penetrated into the Great Basin, there was formerly a much heavier rainfall; so that instead of the existing deserts and salt-lakes, there were large sheets of fresh water, comparable in size with the Great Lakes on the other side of the continent, and, like them, overflowing towards the sea.

It is a most interesting region to the geologist, for the Great Basin well illustrates the formation of lakes through irregular earth-

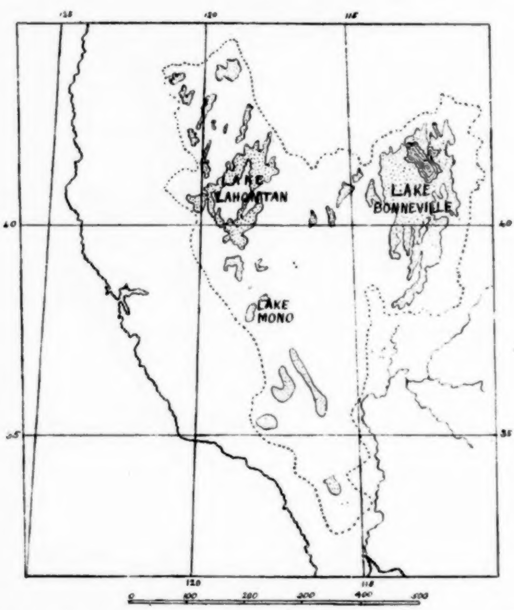



FIG. 1.—The Great Basin and its extinct Lakes. After Gilbert and Russell.

movements. The abandoned beach and shore-lines of the extinct lakes, as Mr. Gilbert has clearly shown, are tilted and deformed in a most remarkable fashion.

The aquatic fauna of the Great Basin, as we should expect in an isolated region such as this, where lakes expand and contract, and their waters change constantly in chemical composition, is an extremely poor one, and seems always to have been poor. From the point of view of the naturalist, these nearly extinct lakes are, therefore, of little importance, for their continuous isolation and the unfavourable conditions have prevented the appearance of a lacustrine fauna and flora of any extent.

The Great Lakes of Canada and the United States form a group too familiar to need description. Their date and mode of origin are as yet unknown, for the glaciation which so influenced the temperate parts of the northern hemisphere has swept away most of the old lacustrine deposits in which was written the ancient history of these lakes. The same glaciation, or the arctic climate that accompanied it, has obliterated the old lacustrine fauna and flora, if a peculiar one ever existed. We thus find that at the present day the inhabitants of the Great Lakes consist merely of the ordinary lacustrine species of North America, with the admixture of a few forms perhaps of marine origin. Too short a time has yet elapsed since the passing away of the arctic climate for a special lacustrine fauna and flora to be evolved in this region, or apparently in any other of the areas which felt the rigour of the cold during the Glacial epoch.

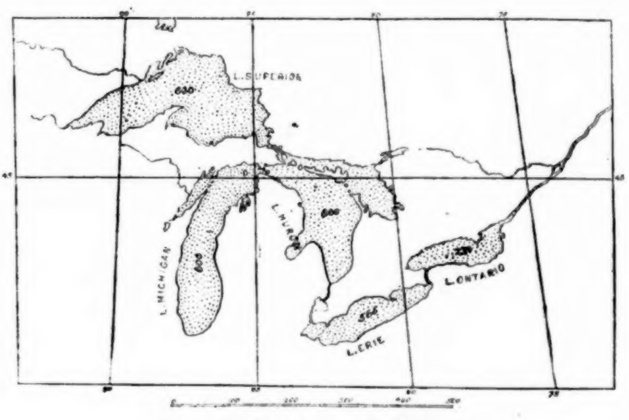



Fig. 2.—The Great Lakes of North America.

From what we have now learnt of the sweeping climatic changes that occurred during the Pleistocene period in temperate regions, it is evident that only in tropical or sub-tropical countries can we hope to find a well-marked and peculiar fauna and flora in each detached basin. Lakes are like oceanic islands. If their fauna and flora has recently been obliterated, they become peopled from the nearest land and will contain no endemic species. Such is the case with the Faröe Islands and with the lakes of Cumberland. If, however, there has been no break in the continuity during long periods, the result is quite different. Accidental introductions will have little chance of establishing themselves in a country already occupied, and each island of a small archipelago, like the Madeira or Galapagos, will contain peculiar species.

The same rule will probably apply to tropical lakes; but, unfortunately, one group only, and that almost unexplored, seems to fulfil the necessary conditions of long-continued isolation and absence

of violent changes. No extensive freshwater lakes are to be found within the warmer regions of the globe, except in Central Africa, and to these we must turn if we wish to study the effects of long-continued and slow change on a lacustrine fauna.

So little is yet known as to the natural history of the equatorial lakes of Central Africa, or of the Tertiary geology of the district, that one cannot speak confidently as to the process of their formation.

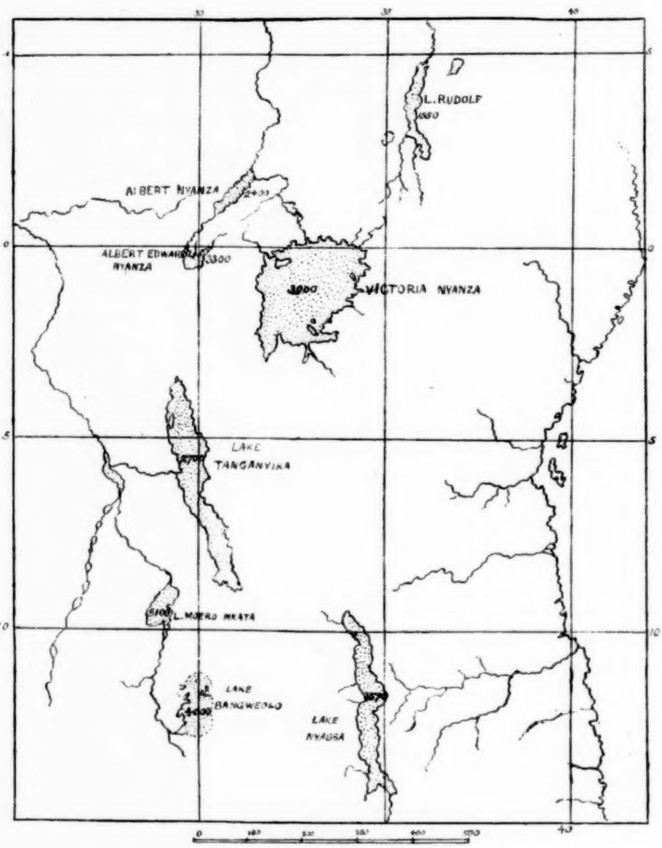



Fig. 3.—The Great Lakes of Central Africa.

Still, however, we have reason to believe that their history has been like that of the Mediterranean lakes before alluded to, except—and the exception is important—that the longer continuance, or greater energy of the uplift in Central Africa, has raised the sea-bottom high above its ancient level and has gradually transformed portions of its area into freshwater lakes.

It will, perhaps, be asked how it is that, notwithstanding our confessed ignorance of the African lakes and their inhabitants, we venture to express any opinion as to their former connection with the sea. Though not much is yet known as to the fauna of these lakes, we are not entirely without information. From the slightly brackish Lake Tanganyika, Mr. Edgar A. Smith has recorded thirty-two species of mollusca, nineteen of which are peculiar to that lake. Among them are two species of a remarkable genus closely allied to the marine *Trochus*, and one or two other shells seem also to suggest marine rather than freshwater ancestors. Lake Tanganyika is now 2,700 feet above the sea-level, but the occurrence in its waters of modified marine mollusca points to the probable elevation of this part of Africa to at least that extent. Till their fauna is better known, we cannot speak confidently as to the origin of the Central African lakes.

The decision of the question How did the African lakes originate? ought to help us to understand various peculiar problems in geographical distribution presented by that continent. Lake Tanganyika, though nearer to the east than to the west coast, overflows into the Congo; the Victoria Nyanza and the associated lakes are connected with the Nile; Lake Nyassa's outlet is towards the Indian Ocean. Thus the African lakes belong to three distinct basins, each probably possessing a peculiar fauna. Most of the great lakes are so near to the watershed that if the higher ones were connected with the sea there might exist an equatorial Mediterranean entirely cutting off South Africa and Madagascar from the rest of the continent. Much has still to be learnt about Africa, and the African lakes evidently contain the answer to many riddles.

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## V.

# Life-Zones in Lower Palæozoic Rocks.

THE "Records of the Rocks," which had been assiduously collected for some time past, were first arranged in definite order by William Smith during the close of the last century and the commencement of the present one. It is well known that Smith's work gave an impetus to the study of Stratigraphical Geology, which resulted in the establishment of a chronological sequence of strata in many areas during the early decades of this century. It is a tribute to the acumen of British geologists that many of the terms which they adopted for the major subdivisions of the strata are now in general use in all parts of the world. But the work of correlation, so enthusiastically commenced, received a check. Dr. Whewell and Mr. Herbert Spencer questioned the possibility of assigning the same age to similar deposits in remote areas, and the difficulties of the task were forcibly presented to geologists by Professor Huxley in his Presidential Address to the Geological Society in 1862. Some time previously to this, M. Barrande (1) had called attention to the apparently anomalous distribution of organisms in the rocks of the Lower Palæozoic Basin of Bohemia, on which was founded his well-known doctrine of "Colonies," and in later publications he instanced a large number of re-appearances of organisms in the rocks of the same basin, which he cited in support of his doctrine. Correlation of strata was, after this, looked upon with considerable suspicion. Nor is this to be regretted, for one result was the diversion of the energies of many most able workers into another field, that of petrological research, which has of late years yielded so many brilliant results.

The then comparatively little known Lower Palæozoic Rocks were, perhaps, the special objects of distrust at the time of which I have been speaking, for it was in these rocks that the colonies were asserted to exist, and subsequent research brought to light a number of other cases of which the once-accepted explanation was strongly adverse to successful correlation. The theory of colonies has now but few supporters, and many of the other apparent cases of anomalous vertical distribution of organisms have been proved to be due to errors of interpretation.

A new era in the study of rocks of greatly disturbed districts was inaugurated by the publication, in 1878, of Professor Lapworth's remarkable paper on "The Moffat Series," (2) in which the method

which that author has called the *zonal* (as opposed to the *regional*), was first applied to the Lower Palæozoic Strata in a detailed manner.

The use of two words has probably done much to retard the general acceptance of this "zonal method;" these words are *zone* and *species*. The physical geologist is naturally alarmed by the use of the term zone, and the biologist by that of species. We may pause for a moment to consider these words.

The adoption of the word zone—a girdle—is unfortunate. Small wonder if there are some who have looked askance at the rapidity with which thin zones were identified in distant regions, and have feared that the task of the modern stratigrapher was akin to that of Puck when he said :—

"I'll put a girdle round about the earth
In forty minutes."

It will presently be shown that the fear is groundless, for the zones are in reality far from being universally distributed. They are in no sense girdles.

The biologist justly asks how we can tell that a form is a distinct species, when the soft parts are not preserved. May it not be merely a variety? Certainly it may be, but it is of value to the stratigrapher for all that. There are two kinds of variety. Firstly, the departure from the normal form, which co-exists with that form; the number of variations of form presented by the shells of *Terebratula biplicata* in the Cambridge Greensand illustrates this; such variations, though interesting to the biologist, are useless to the stratigraphical geologist for the purpose of defining zones. The other variations are found, by experience in the field, to mark successive periods of time. A palæontologist whose sphere of work was limited to the museum, would see nothing by which he could separate these varieties from the former, but they are all-important to the stratigrapher, and it matters not to him whether they are true species or merely varieties of an earlier species, for they mark definite horizons. Dr. W. T. Blanford some time ago remarked to me that a distinctive term was wanted for such a variety, and I would suggest the term Exallage (ἐξαλλαγη, a variety "from what has previously been").

We may now proceed to consider the manner in which life-zones have been established amongst the strata, and to defend their utility. Though many sets of life-zones have been established, as for instance in the Upper Cretaceous Rocks by the use of echinoids and other forms of life, and in the Jurassic Rocks mainly by the use of Ammonites, I shall refer chiefly to the graptolite-zones of the Lower Palæozoic Rocks, as my practical knowledge of zones is chiefly confined to those of the last-named strata.

Let us consider first the relative value of different groups of organisms in working out zones. Hitherto special use has been made of the graptolites, and they are, when found, extremely valuable on account of their abundance and the frequency with which they are

preserved in a perfect or nearly perfect condition; but they cannot always be obtained, and in such cases corals, brachiopods, trilobites, and other forms will be found serviceable. The trilobites have already been extensively utilised by the Scandinavian and Russian geologists, and they will probably yield more valuable assistance than heretofore in our own country when they have been more fully studied with reference to their distribution in the field. Some of our "species," such as *Cheirurus bimucronatus*, probably contain many "exallogous" forms which are of value for stratigraphical purposes.

The actual utility of different forms of fossils for determining horizons can only be ascertained by working out their vertical ranges in the strata. It is a well-known fact that some fossils have a longer range than others which are closely allied to them; for instance, in the Llandovery Rocks of the Lake District, *Monograptus gregarius* ranges through more than thirty feet of rock, while *Monograptus argenteus* is limited to eight inches of the same set of strata.

When an organism has a long range it by no means follows that it will be found equally distributed throughout all the strata included in its range, and so we get re-appearances of a form. Among the many cases of re-appearance noted by Barrande among the rocks of the Bohemian Basin (3), two of the most noteworthy are those of the trilobites *Æglina rediviva* and *Dionide formosa*, which have been found in the bands *d* 1, *d* 3, and *d* 5, but have not been recorded from the intermediate bands *d* 2 and *d* 4. It is not necessary to suppose that these creatures migrated from the Bohemian area during the deposition of the bands *d* 2 and *d* 4. If they lingered in diminished numbers in the area during a period marked by conditions unfavourable for their existence, they might well escape the notice of collectors.[1] It is evident that recurring forms are not adapted for marking zones. They do not, however, raise any real difficulty when zones are being established, for they are not usually prominent forms, and, what is of more importance, the association of other organisms is different in the beds in which a particular organism recurs, from that which is found in the beds in which it first appears. From this consideration, it follows that a successful establishment of zones will more probably be made if the organisms associated with the form after which the zone is named be also carefully noted, and this is constantly done by those who use the "zonal method."

Another possible cause of suspicion is the frequent thinness of the deposit marking each zone in the area in which such zones were first determined. It is, however, natural that such determinations should be made in areas of exceptionally thin deposits, for there many zones may be studied in the course of a single section; and it is not only easier to establish zones in such an area, but when a thick

[1] In illustration of this I may notice that during the summer of 1876 the butterfly *Erebia cassiope* swarmed on many of the hills of the Lake District. Since that time I have not seen one, though I have usually spent my summers in the district.

group of deposits is studied, there is a tendency to speak rather of series or stages than of zones. Nevertheless, the term is not applied merely to thin deposits, but also to groups of considerable thickness, when a particular form is characteristic of a group of strata. Professor Lapworth, when commenting upon the thinness of the Stockdale shales (4) (divisible into nine graptolitic zones), pointed out "that they were represented by very great thicknesses of deposit elsewhere; thus, the Browgills were represented by thousands of feet in the Bala group and the Tarannon, and the Skelgills by enormous thicknesses in Girvan and Central Wales." The various zones of Llandovery-Tarannon age are traceable also in these expanded deposits, and there each zone is of very considerable thickness. I have elsewhere spoken of the Lower Ludlow Rocks of Bohemia as the zone of *Monograptus colonus*, and there is no reason why the term should not be applied to those beds, though, doubtless, a more intimate acquaintance would show that they might be split into smaller zones or sub-zones. The beds of this age in Bohemia are not very much thicker than some of the recognised graptolite zones of typical areas in Britain; but in the English Lake district we find that these Lower Ludlow Rocks (*i.e.*, the zone of *Monograptus colonus*) have an estimated thickness of about 10,000 feet, and although this may be an exaggeration, there is no doubt that they must be put down at many thousands of feet.

The above remarks lead us to consider the lateral extension of zones as hitherto traced. Using the term zone in the widest sense in which it has been applied, we find zones characterised by a particular genus having a very extended geographical distribution. The zone of *Dictyograptus* has been recognised in Britain, Belgium, Russia, Scandinavia, and America; that of *Bryograptus* in Britain, Scandinavia, and America, and that of *Phyllograptus* in these three countries, as well as in Australia. There seems no reason why strata characterised by particular *genera* should not be spoken of as zones, and indeed we have long been accustomed to speak of the zone of *Micrasters*, and, more recently, of the *Olenellus* zone. At present, however, we may confine our attention to such zones as are characterised by the existence of forms which are usually spoken of as species. These zones vary in different ways, when traced laterally. It has already been pointed out that they frequently expand considerably when followed from one area to another, and, on the other hand, they thin out to such an extent as sometimes to disappear altogether. Thus the *Rastrites maximus* zone of the Stockdale shales is found near Sedbergh, but does not occur in the Lake district, and study of the deposits points to the conclusion that it has actually thinned out, and is not represented by any sediment. In such a case the absence of sediment in an area during the time that the deposits of a zone are being laid down elsewhere, will result in the production of a plane of stratification, marking the position of

the zone. According to Professor Lapworth (5), the fossiliferous zones of the Moffat series "disappear one by one from above as we pass over the Uplands from south-east to north-west." Furthermore, the sediments of a zone may vary considerably when traced laterally, whilst the fossils remain the same. The graptolites of the Lower Ludlow beds are similar in the limestones of Bohemia, the shales of Scandinavia, and the grits of the north of England. At other times, both the lithological characters and the organic contents of corresponding strata are different in two areas. In such cases, as a rule, only general comparisons can be made, and a minute zonal subdivision of the strata cannot be attempted.

The most rigid test to apply to the zonal method, if we wish to ascertain its value, is the examination of the fossils of zones, with a view to discovering whether there is not an inversion of the order of some of the zones in different areas. So far as I am aware, the extensive exploration that has been carried on amongst the Lower Palæozoic Rocks has hitherto brought to light no case of the inversion of order of two zones in any two areas. It would be tedious to give instances of the constancy of order of such zones, but they may be readily found by searching the papers which, during the last fifteen years, have been devoted to the distribution of the graptolites. It is difficult to see how, on any view save that of the contemporaneity of the strata, marked by the inclusion of the same fossils, we are to account for this absence of inversion. It might be produced by the successive zone-forms originating in one, and only one, area, and spreading away from thence; but such a supposition, though perhaps just conceivable, is in the highest degree improbable, and viewing all the evidence, not of the graptolites only, but of other forms also, may be rejected. But all difficulties vanish if we allow sufficient *time* for the accumulation of the strata. Surely the time taken for the spread of an organism by transport or migration would usually be short, as compared with the time during which that particular form existed. Where a species is limited to a few feet of strata, the time during which that species spread may be represented by less than an inch of deposit. In this case, the zones, though not actually begun and ended at the same time, are for all practical purposes contemporaneous. We should speak of a man who was born in 1800, and who died in 1870, as the contemporary of one who was ushered into the world in 1801, and left it in 1871; and in a science like geology, where accurate estimates of time are at present impossible, and seem likely always to remain so, a similar use of language is fully justifiable. If the value of zones depends on the comparative rapidity of dispersal of organisms, a group of organisms should be of more or less value according to its capacity for rapid dispersal; and if this be so, some forms should be more useful than others in marking zones. It is very probable that such freely floating creatures as graptolites were more easily dispersed from their centres

of origin than were animals of other groups, but at present we cannot say much upon this head, for we do not know how far other groups will yield "exallogous" forms, after a further study of the vertical distribution of the "species."

Hitherto I have made no attempt to give a definition of a zone. It is advisable, as in the case of other stratigraphical divisions, not to insist on too rigid a definition. A zone may be defined as a *stratum or set of strata characterised by an organism, which may or may not be the dominant form of that zone, but which is nearly or entirely confined to it, and from which it takes its name; it usually contains an assemblage of other forms occurring in similar association in that zone only; it may be of considerable thickness, and may contain material of different composition in different parts of its extent.* Such a definition permits the use of the term for deposits characterised by genera, species, or even varieties. Some authors speak of a zone when the form after which the zone is named is absent. It is an open question how far this is desirable, but in practice little harm can result, if the absence of the characteristic fossil is noted, and the evidence for the identification of the zone is fully given. It is clear that the assemblage of fossils other than the characteristic one will not be constant in all areas in which the zone is found, so that the stratigraphical geologist must necessarily exercise his judgment in determining how far it is safe to subdivide a group of deposits into zones, and to correlate these with one another in different areas. The success of such correlation will depend upon the cumulative evidence.

I shall devote the latter part of this article to a discussion of the value of the zonal method to the geologist. It is above all things of value as furnishing a chronological index, by which we may fix the relative dates of the different events, which taken together constitute the earth's history. As Sir A. Geikie observes (6), stratigraphical geology "gathers up the sum of all that is made known by the other branches of the science, and makes it subservient to the interpretation of the geological history of the earth." Now it is impossible to read that history aright, unless we have a trustworthy chronological index, and this consideration probably influenced those who, alarmed by the jeremiads of eminent men of science, abandoned the study of stratigraphical geology, to pursue the subject along what seemed to be more promising lines. It is indeed difficult to see what would be the ultimate value of geology if our stratigraphical chronometer were untrustworthy; no detailed study of the mineral composition, organisms, and physical changes of our globe could furnish material for a connected history of that globe. But the institution of the zonal method has given us a brighter outlook, and already we have gained knowledge which has been turned to excellent use. I may refer, in support of this remark, to the discovery of the "Secret of the Highlands," and to the establishment of a horizon—the *Olenellus* zone—which enables us to fix the upper limit of the pre-Cambrian Rocks.

Another use which can be made of the method we are studying is the more accurate estimate of the physical conditions under which groups of strata were deposited. This kind of work has hitherto been carried on in a somewhat haphazard way as far as the Lower Palæozoic Rocks are concerned, but as an example of the results which we may eventually get by careful study of zones, I may point to Professor Lapworth's admirable section showing the lateral changes observable in the Ordovician and Silurian strata of the Southern Uplands, appended to his paper on the Ballantrae Rocks, which appeared in the *Geological Magazine* for 1889.

The study of zones not only throws light upon the physical conditions under which they were deposited, but also gives us additional evidence of the value of these zones. The expansion of thin masses of shale into much thicker deposits elsewhere, and the swarms of fossils occurring in those deposits, has been held for some time to indicate that the thin sets of strata were formed far from land, and this is supported by observation of the nature of the included fossils. It has been shown by Dr. Hinde that deposits of radiolarian chert are associated with the graptolitic shales of Scotland, and these have been compared with similar modern deposits formed in deep sea. Professor Suess has given instances of trilobites amongst the Lower Palæozoic Rocks which strikingly resemble modern deep-sea crustaceans in more than one respect, and such trilobites are found amongst the strata which are divisible into thin zones. It would seem, therefore, that the evidence points to such rocks having been formed in seas far away from land, and in that case we need not be surprised at the very wide geographical distribution of the organisms of the zones.

The inquiry into the cause of zones may possibly throw some light on climatic change, though here we are touching upon a question upon which it would be premature to speculate. Suffice it to say, that the sharp line of demarcation between many zones does not appear to be due to change in the physiographical conditions of the area (apart from climatic change), for we find sediment having the same lithological characters, divisible into several distinct life-zones, and, as already stated, the same zone may be traced among strata of very different lithological characters.

In studying the phylogeny of different groups of organisms, the establishment of zones will prove invaluable. Numerous errors have shown the danger of attempting such a phylogeny by a study of fossils in the Museum, without reference to their order of appearance in the strata. On the other hand, an earnest of what may eventually be done is furnished by the contribution to the study of the descent of the later graptolites given by O. Hermann in his monograph of the Dichograptidæ.

The zonal method has "quietly entered upon what may be regarded as the accepted or orthodox stage"—so wrote Professor

Lapworth in 1889. It now remains to apply that method to the more accurate correlation of the strata of the earth's surface, for hitherto the work has been only commenced. The geologist of the future will gather a valuable harvest from the material that his predecessors have collected. We must be, in the main, content patiently to collect that material, comforting ourselves with the knowledge that brilliant speculations, founded on insufficient data, have usually but a brief existence, while a collection of accurate facts is of service for all time. We need not fear that our energies will be altogether exerted in cataloguing facts; every careful piece of work assists in the establishment of some new truth, or the acquisition of fresh ideas.

The Stratigraphical Geology of the future will not consist almost exclusively of the enumeration of the order of succession of deposits, their thicknesses, their lateral variations, and their fossil contents. The earth-movements, the vulcanicity, the metamorphic changes, the climatic variations, and the life-history of each period will be more fully elucidated, and the elaboration of a true Earth History will be possible. In the meantime, we rejoice to see Stratigraphy once more placed upon a firm basis, and, while still indebted to her early handmaid, Palæontology, having fresh life infused into her by contact with the young and vigorous Petrology.

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VI.

# A New Group of Flowering Plants.

QUITE recently the study of a genus of flowering plants, in many respects very peculiar, has led to most interesting results. The genus *Casuarina* occurs chiefly in Australia, but is also met with in Tropical Asia and Madagascar. In Australia it is known as the She-Oak, but it is hard to understand why, unless, perhaps, from its hard and heavy wood. The leaves are reduced to tiny scales, borne in whorls on long green whip-like branches. The male flowers are borne on spikes and consist of solitary stamens surrounded by four bracteoles; the female flowers are borne in capitula, on twigs and branches of a very different age, and may often be found in the old wood of thick branches. So unlike is the genus to any other, that it has hitherto had a natural order to itself, styled Casuarineæ, and placed in the Apetalous group of dicotyledons. Its affinities have always been regarded as most obscure, and the order as very distinct from all other dicotyledons.

At the close of last year, Dr. Melchior Treub, director of the Botanic Gardens at Buitenzorg, Java, published the result of some detailed researches, "Sur les Casuarinées et leur place dans le Système Naturel." The results are startling, as may be judged from the fact that they have led their author to place the Casuarineæ by themselves in a distinct sub-division of the Angiosperms. This is not the first time that Dr. Treub has made the *Annales du Jardin Botanique de Buitenzorg* the medium of a most important morphological communication. In 1881, he communicated an important paper on the Cycads, including many new facts relating to the development of the macrosporangium, and in 1884 the first complete account of the structure and life history of the prothallium of Lycopodium, which he had succeeded in cultivating from the spore, and also found growing naturally. It may be interesting to give a brief *résumé* of his latest researches.

At the outset, however, we may briefly review the structures which are now generally regarded as of primary importance in the classification of plants into large groups. A true appreciation of the principle of the Alternation of Generations forms the basis of the whole subject.

The alternation is clear enough in the Ferns. It is a matter of common observation that the tiny spores borne in great profusion,

usually on the back of the fertile leaves, produce on germination not a new fern-plant, but a small green expansion showing no differentiation into stem and leaf, and attached to the soil only by a few colourless root-hairs. From this expansion, the *prothallium*, arises a new fern-plant similar to the original spore-producing individual. This new plant is the result of a sexual process. On the under surface of the prothallium are two sets of organs, the male, or *antheridia*, containing the male cells or *antherozooids*, and the *archegonia*, or female organs, containing the female cell or *oosphere*. The antheridium consists merely of a wall of a single layer of cells enclosing the naked unicellular spirally-coiled antherozooids. The archegonium consists of four rows of cells forming a projecting neck, round a row of *canal-cells* terminating at the central cell or *oosphere*. Fertilisation takes place by the rupture of the wall of the antheridium, and the escape of the antherozooids which swim about in the water present and are attracted to the archegonium by a mucilaginous secretion resulting from the disorganisation of the canal-cells. They pass down the passage thus formed and penetrate the naked oosphere, which is at once invested with a cell-wall and becomes the *oospore*. On germination, the oospore produces the young fern-plant.

We may represent the life history in a tabular form :—

Asexual generation .. .. .. { Fern plant
| Spore

Prothallium

Sexual generation .. { Sexual organ Antheridium .. Archegonium
Sexual cell Antherozooids = Oosphere
Oospore

Fern-plant No. 2.

In this case the sexual generation represented in the prothallium is quite distinct from the previous asexual generation or fern-plant, and also gets quite free from the spore.

The spores are contained in small roundish capsules, the *sporangia*—there are usually sixteen in each—arising from the division of a single central cell, the *archesporium*. They are set free by the bursting of the sporangium-wall. The true Ferns are *homosporous*, *i.e.*, produce only one kind of asexual spore, and one prothallium bears both antheridia and archegonia, but the nearly allied Rhizocarps, which include *Salvinia* and *Pilularia* (the Pillwort, a local British plant), are *heterosporous*. Two sorts of spores are produced in two sets of sporangia. The smaller *microsporangium* produces a number of small spores, *microspores*, and the larger *macrosporangium* one large *macrospore*. The indication of sex has been carried back into the asexual generation as far as the sporangia, but both kinds of sporangia are

borne on the same leaf, though this has become considerably modified and differs remarkably in appearance from the vegetative leaf.

The prothallium resulting from the microspore is very simple. In *Pilularia*, for instance, the spore divides into three cells, the smallest representing the prothallium, while the other two together form the antheridium, and, by repeated bipartition, give rise to sixteen naked antherozooids. The prothallium and antheridium remain enclosed in the spore, which ultimately bursts to allow the escape of the antherozooids. The macrosporangium, like the microsporangium, becomes separated from the leafy asexual plant, but the macrospore never gets quite free, although in course of growth it ruptures the sporangium wall above.

The female prothallium, like the male, is very simple and contained in the spore, forming a small green structure on which one or more archegonia are developed in the same way as in the homosporous Ferns. The sporangium and spore become ruptured near the apex to give access to the antherozooids.

We may represent the life history thus :—

| | | | |
|---|---|---|---|
| | Stem- and leaf-bearing plant | | |
| Asexual generation .. | Microsporangium | | Macrosporangium |
| | Microspores | | Macrospore |
| Sexual generation .. | Male prothallium | | Female prothallium |
| | Antheridium | | Archegonium |
| | Antherozooids | = | Oosphere |
| | | Oospore | |
| | New stem- and leaf-bearing plant. | | |

Besides the homosporous and heterosporous ferns, the group Vascular Cryptogams comprises also the Equisetineæ, or Horse-tails, and the Lycopodineæ, including the Lycopodiaceæ, or Lycopods proper (Club-mosses), and the Ligulateæ, comprising *Selaginella* and *Isoëtes* (the British Quillwort). Of these the Equisetineæ and Lycopodiaceæ are homosporous, while *Selaginella* and *Isoëtes* are heterosporous. The sporangia are produced, not from a single cell, as in the Ferns, but from a group, which forms a hemispherical protuberance on the under margin of the modified, peltate scale-leaf of the Equisetineæ, or in the upper surface of the base of the leaf in the Lycopods, in the hollow of the leaf-sheath of *Isoëtes*, or on the stem just above the leaf-base of *Selaginella*. The archesporium is either a single cell beneath the epidermis, as in Equisetineæ, or a hypodermal layer, as in *Isoëtes*.

If we follow the process in the macrosporangium of *Isoëtes*, we find that the cells of the archesporium elongate and divide by transverse

walls; single longitudinal rows grow less rapidly and form sterile trabeculæ separating the rows of fertile cells. The latter give rise to a few *tapetal* cells by transverse division towards the outer wall and one sporogenous cell, the mother-cell of the macrospores, which becomes rounded off and grows considerably, destroying and using up the tapetal and neighbouring cells, till it thus comes to lie in a cavity of the sporangium, where it divides into four daughter-cells, the macrospores.

The germination of the male or microspore somewhat resembles that of the Rhizocarps.

The macrospore in *Isoëtes* a few weeks after being set free from the decaying macrosporangium, becomes filled with cells, which are at first naked, but when the spore is quite filled become invested with a cell-wall. The prothallium then occupies the whole interior of the spore, which now bursts at the apex, and one or, if necessary, more archegonia are developed on the exposed portion of the prothallium.

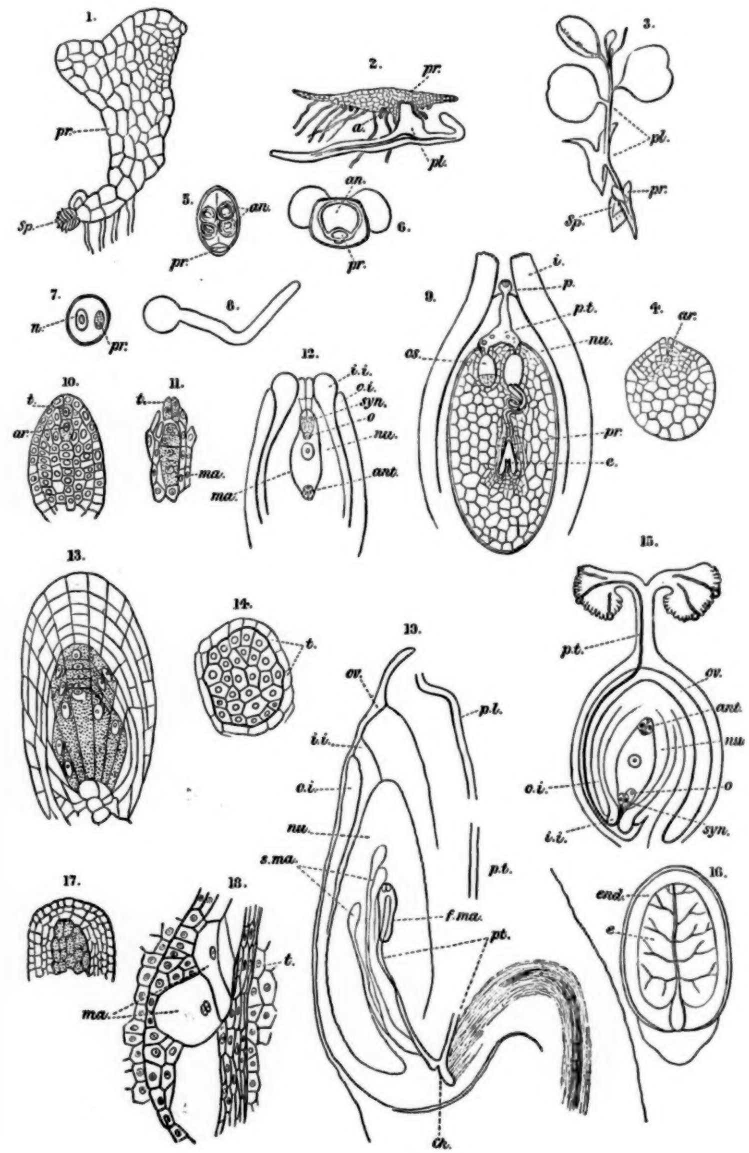
The alternation of sexual and asexual generations is evident in all these families classed together in the great group of Vascular Cryptogams. In every case the sexual generation, though it may not escape from the spore, and sometimes not even get quite free from the sporangium, as in *Salvinia*, is yet distinct from the always conspicuous asexual plant, with its evident differentiation into root, stem, and leaf. It was not until Hofmeister published his "Comparative Researches," in 1851, that the relation became clear between the higher plants, the Phanerogams, or *Seed-plants*, and the Vascular Cryptogams. We now understand that the same principle runs through the life history of all, and the accurate correlation of the organs in the two great classes has thrown a much clearer light on the principle of classification. Phanerogams are characterised by producing a seed, and it is by the proper comprehension of the development of the seed that we are able to understand these relations.

Phanerogams are heterosporous, and the indication of sex has penetrated far into the asexual generation. There are not only two sets of sporangia, but two sets of modified leaves to bear them. Those which bear the microspores are the *stamens*, while the *carpels* have the same relation to the macrospores. Stamens and carpels are commonly associated in the *flower*, a structure unknown in the Cryptogams, but developed in the Phanerogams to ensure the protection of the "essential" sexual parts, and the proper performance of their functions. The method of production of the microspores or pollen-grains follows a general plan similar to what obtains in the microsporangium of Vascular Cryptogams like *Isoëtes*. The pollen-sac, or sporangium, arises from a group of cells sometimes on the underside of a leaf-like stamen, as in Conifers, sometimes, as in Angiosperms, several together, forming the anther at the apex of the

very modified staminal leaf. The sporogenous tissue is the product of an archesporium and is surrounded by tapetal cells. The microspores or pollen-grains are formed by division of the mother-cells into four daughter-cells, but the development of the macrospores is of greater interest.

Let us first consider the Gymnosperms, as it was here that the relation to the Vascular Cryptogams was first pointed out by Hofmeister. The *nucellus*, or group of cells composing the sporangium, is surrounded by a single integument, except at the apex, where an open passage is left, the *micropyle*. The macrospore or *embryo-sac* is produced from a hypodermal archesporium, which is covered above by tapetal cells as in *Isoëtes*. The archesporium may divide by a few shiny transverse walls into a row of cells, the lowest one of which is the macrospore, as for instance in the Larch (*Larix*). In the Cypress (*Cupressus*) and *Callitris*, the archesporium may, however, divide further, forming a group of cells, as happens also in the Cycadeæ. A sporogenous tissue is thus produced; all the cells are, however, sterile except the one which produces the embryo-sac, and are replaced, as in *Isoëtes*, by the growing macrospore. There is, moreover, a difference from the Vascular Crytogams, in that the mother-cell does not divide by a repeated bipartition into four daughter-cells or macrospores, but elongates and divides by superposed transverse walls. In the Cycads, the cell-wall of the embryo-sac thickens and splits into two layers, the outermost of which is cuticularised like the membrane of a macrospore, which will be set free from the sporangium. The embryo-sac remains in the nucellus, almost the whole of which it occupies, and the nucellus remains attached to the carpel, and thereby to the parent plant. The macrospore germinates as in *Isoëtes*. The nucleus, by repeated bipartition, gives rise to a number of free nuclei round which cells are formed; these grow and divide in such a way as to fill the macrospore with the tissue of the prothallium. Archegonia are formed at the apex from single superficial cells of the prothallium in the same manner as in the Vascular Cryptogams.

It is obvious, however, that fertilisation cannot be affected in the same way. In Vascular Cryptogams the prothallium, either free or still contained in the ruptured spore is found on damp ground or in mud at the bottom of water. But free-swimming antherozooids would be incapable of penetrating to the oosphere borne high and dry on the cone of a Fir-tree. Hence the mechanism is different. The pollen-grains when set free from the pollen-sac, contain an indication of a prothallium in one or two cells cut off from the rest of the contents. The light grains, produced in large quantities, are carried by the wind. Some find their way to the carpel and the micropyle of the ovule, and pass through it to the apex of the nucellus. The antheridial cell grows out as a short tube into the tissue of the nucellus, where it remains stationary for a time. Then, when the oosphere is




## EXPLANATION OF PLATE.

Fig. 1.—Fern-prothallium (*pr.*) developed from the spore (*sp.*) to which it is still attached.

,, 2.—Fern-prothallium (*pr.*) quite freed from the spore, and bearing the young asexual plant (*pl.*) *a*, an archegonium, the oosphere of which has not developed (longitudinal section).

,, 3.—Young asexual plant of *Salvinia* (*pl.*) borne on the prothallium (*pr.*), which has not become quite freed from the macrospore (*sp.*).

,, 4.—Longitudinal section through a macrospore of *Isoëtes* filled with the prothallium which bears an archegonium (*ar.*) at the apex.

,, 5.—Microspore of *Isoëtes*, showing formation of antherozooids (*an.*); *pr.*, prothallium-cell.

,, 6.—Microspore (Pollen-grain) of *Pinus sylvestris*; *pr.*, prothallium-cell; *an.*, antheridial cell, which will grow out as the pollen-tube.

,, 7.—Pollen-grain of an Angiosperm; *n.*, nucleus; *pr.*, prothallium-cell.

,, 8.—Ditto, in germination, showing production of pollen-tube.

,, 9.—Longitudinal section of ovule of a Gymnosperm, showing contents of macrospore (embryo-sac), method of fertilisation and development of embryo; *i.*, integument; *nu.*, nucellus; *pr.*, prothallium (endosperm) contained in the embryo-sac; *os.*, oospore, showing primary cell divisions as result of fertilisation; *e*, embryo developed from the other oospore with which it is seen to be still connected; *p.*, pollen-grain germinating in the micropyle; *p.t.*, pollen-tube which has fertilised the oospheres.

,, 10.—Longitudinal section through the young ovule of an Angiosperm. Two cells are distinguished by size and contents from the rest of the nucellus; *t.* is the primary tapetal cell, *ar.* the archesporium.

,, 11.—Later stage of 10. The archesporium has developed into a row of cells, the lowest of which (*ma.*) will become the embryo-sac.

,, 12.—Still later stage of same, showing the ovule, consisting of nucellus (*nu.*) and outer (*o.i.*) and inner (*i.i.*) integuments, and also the contents of the embryo-sac (*ma.*); *o.*, oosphere; *syn.*, synergidæ; *ant.*, antipodal cells.

,, 13.—Longitudinal section of nucellus of *Rosa livida*, showing the sporogenous tissue distinguished by great elongation of the cells, large nuclei, and conspicuous cell-contents. Tabular tapetal cells, also distinguished by nuclei and contents, are seen above the sporogenous tissue.

,, 14.—Sporogenous tissue of a Cycad surrounded by a layer of tapetal cells (*t.*).

,, 15.—Longitudinal section of ovary of Angiosperm at the time of fertilisation; *ov.*, ovary-cavity; *o.i.*, outer integument of ovule; *i.i.* inner ditto; *nu.*, nucellus containing the mature embryo-sac in which are seen *o.*, the oosphere, *syn.*, synergidæ, *ant.*, antipodal cells; *p.t.*, pollen-tube making its way from the grain which germinated on the stigma, down the style and through the ovary-cavity and micropyle to the apex of the nucellus.

,, 16.—Seed of an Angiosperm containing the embryo (*e.*) surrounded by endosperm (*end.*).

,, 17.—Longitudinal section of nucellus of *Casuarina* showing development of sporogenous tissue (dark-celled). After Treub.

,, 18.—Longitudinal section of sporogenous tissue at a later stage, showing the large macrospores (*ma.*). A tracheid is indicated at *t.* After Treub.

,, 19.—Longitudinal section of ovule after passage of pollen-tube; *ov.*, ovary-cavity; *o.i.*, *i.i.*, outer and inner integuments; *s. ma.*, sterile macrospores; *f. ma.*, fertile macrospore containing sexual apparatus; *ch.*, chalaza; *p.t.*, pollen-tube passing down the tissue of the placenta to the chalaza, where it branches, the main branch passing up the tail of a sterile macrospore (not indicated) and becoming attached to the fertile macrospore. The constriction of the pollen-tube is shown.

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mature and ready for fertilisation, the tube begins to grow again through the nucellus, reaches the apex of the embryo-sac, and thrusts between the neck-cells of the archegonia protuberances which finally reach the oosphere. A number of small nuclei have been formed in the extremity of the pollen-tube from the original antheridial nucleus; these disappear in fertilisation, and their substance in some way or other passes into the substance of the oosphere, which thus becomes the *oospore* and is invested with a cell-wall. From the oospore is produced the embryo. Meanwhile, the integuments of the ovule, together with what remains of the nucellus, have become thickened and hard or leathery, forming the coats of the seed, which is now ready to leave the parent, carrying a miniature of it in the enclosed embryo. The life history of a typical Gymnosperm, say the Scotch Fir (*Pinus sylvestris*), will be as follows:—

```
                                          Scotch Fir Tree
                                                |
                               -----------------------------------
                               |                                 |
                             stamen                            carpel
Asexual generation             |                                 |     { nucellus
                 Sporangium  pollen-sac                        ovule   { integument
                               |                                 |
                 Spore       pollen-grain                      embryo-sac
                               |                                 |
                        ---------------                          |
                        |             |                          |
                 prothallium  sterile cells                    endosperm
Sexual generation..                   |                          |
                                      |                        archegonium
                                 pollen-tube }                   |
                                             } =               oosphere
                                                  |
                                               oospore
                                                  |
                                           Scotch Fir Tree.
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The great difference, from this point of view, between the Gymnosperms and Vascular Cryptogams, is the complete merging of the two generations in one individual, and the entire dependence of the sexual generation for nourishment and support on the previous asexual one. This results in the production of the *seed* in which the second asexual generation is finally dispatched to start a separate existence.

Coming now to the highest group, the Angiosperms, the plants with an ovary, we shall find important differences.

As regards the macrosporangium, the nucellus is protected by one or two integuments. In the simplest case a sub-epidermal cell, which is the archesporium, also becomes the macrospore (embryo-sac). This occurs in *Lilium bulbiferum*, but is rare. We usually find the type established by Strasburger. One sub-epidermal cell, the archesporium, divides transversely. The upper daughter-cell grows and divides, giving rise to parietal and tapetal layers, while the lower, the mother-cell of the macrospore, divides by one or several shiny, transverse walls, and one of the resulting series of cells, almost always the lowest, becomes the

embryo-sac, growing enormously, and crowding and absorbing its sister-cells. In rare cases, one of the latter develops further, but never far enough to give it the character of a sterile macrospore, a rank which it certainly holds theoretically. Sometimes the nucellus contains two or even several embryo-sac mother-cells. Thus, Strasburger saw four in *Rosa livida*, and this supports the view that we are dealing with rudimentary sporogenous tissue. In this case, usually one of the daughter-cells from the commencement crowds and absorbs, before they have reached any development, not only its sister-cells, but also those arising by division of the other mother-cells. Occasionally, some may develop enough to assume the appearance of sterile macrospores, but it is very rare that one of them succeeds in reaching to the formation of the sexual apparatus, as Fischer saw in *Triglochin palustre*, and this, too, eventually disappears.

As regards the development of the macrospore, there is a profound difference from what we have hitherto seen. The nucleus of the embryo-sac divides into two; this is twice repeated, and each group of four nuclei retires to one end of the oval embryo-sac. Three at the apex become surrounded with protoplasm and form naked cells—the *oosphere* and two others termed *synergidæ*. Three at the opposite end also form cells which become invested with a cell-wall and are known as antipodal cells; their function is unknown. The synergidæ assist in the process of fertilisation; they may be regarded as "endosperm cells which by an adaptation to a new function have acquired a special form and place." The remaining pair of nuclei again advance to the centre and join, forming a central nucleus. The pollen-tube grows down the tissue of the ovary to the micropyle, passes through this, and becomes attached to the embryo-sac (which has occupied almost the whole of the nucellus) just above the oosphere.

Fertilisation occurs as in the Gymnosperms and the resulting oospore becomes at once invested with a cell-wall. The development of the embryo is on a similar plan to that in Gymnosperms, and differs entirely from the mode of formation in Vascular Cryptogams.

After fertilisation, and during the early stage of embryonic development, the nucleus of the embryo-sac, by repeated bipartition, forms a number of free nuclei, and the sac becomes filled with endosperm tissue. Similarly the ovule becomes the seed.

It is evident that in Angiosperms the female sexual generation is reduced as far as possible. The prothallium is represented by the synergidæ and, perhaps, the antipodal cells. The archegonium has been reduced to the central oosphere. The endosperm formed after fertilisation must probably be regarded as a new formation, and not strictly comparable to the endosperm of Gymnosperms, which is the true homologue of the prothallium of Vascular Cryptogams.

We have thus accounted for the sub-division of the seed-plants as at present accepted.

Seed-plants (Phanerogams).

| Division I. | Division II. |
| --- | --- |
| Gymnosperms. | Angiosperms. |
| Ovule naked on the carpel. | Ovules borne in an ovary. |
| Distinct female prothallium present bearing archegonia as in the Vascular Cryptogams. | Female prothallium extremely rudimentary, and the female organ reduced to the oosphere. |

Let us now return to Dr. Treub's recent work. He first gives a clear account of the development of the ovary and ovules on which our knowledge has hitherto been "inexact and incomplete." The ovary is formed of two carpels, which at first include an ovary cavity, but the cavity subsequently disappears almost entirely, and is only indicated again when the ovules begin to develop. One is produced from each carpel, but an inequality is early noticeable between the two protuberances from which they are developed, the smaller forming only a sterile ovule. They are separated by the cellular mass of the placenta and are semi-anatropous.

Section 2 deals with the sporogenous tissue and the macrospores. The archesporium consists of four large subepidermal cells, by the growth and division of which is produced a fairly thick cylinder of sporogenous tissue in the centre of the nucellus, quite distinguished by the large size of the cells from the enveloping layers. An intercalary growth at the base connects the sporogenous tissue with the *chalaza*, where the tissue of the nucellus is attached to the funicle or stalk of the ovule. The large cells of the sporogenous tissue are embryo-sac mother-cells. They divide rapidly by transverse walls, which are thick and shiny like the walls of the embryo-sac mother-cells of other Angiosperms. Three differing elements result from this division:

1. Small cells with a dense protoplasm and big nucleus. These are ultimately, but *not at first*, crushed and absorbed by the macrospores.

2. Large cells or macrospores.

3. Tracheides. These Treub compares with the elaters of Hepatics, though their function is unknown. They occurred in two out of the three species examined.

The macrospores grow rapidly, producing long tails, which often penetrate the chalaza. The number developing may be considerable, in *Casuarina suberosa* as many as twenty; where they are very numerous, some in the region of the micropyle do not produce tails.

As regards the contents of the macrospores, we must distinguish between sterile ovules and those which will be fertilised. In the former, Treub rarely saw tails to the macrospores, the latter increasing

in size without elongating, and often containing two fairly large nuclei. In the fertile ovules, those macrospores which are well developed, that is, the majority, include at the apex two or three cells, rarely only one. These are usually naked, but sometimes have cellulose walls, and their arrangement seems to indicate that they have come from one primary cell. This is the sexual apparatus. In the great majority of cases there is only one macrospore in the nucellus in which the sexual apparatus has the cellulose walls; this is the future fertile embryo-sac. Occasionally, however, there is more than one in which this is the case. The perfect equivalence of the future embryo-sac and the sterile macrospores thus admits of no doubt.

Section 3 deals with the pollen-tube and the fertile embryo-sac. Treub finds that the pollen-tube does not enter the ovary cavity, and does not pass down the micropyle, but enters the nucellus at the opposite end, namely, at the chalaza. Only one pollen-tube enters each ovary. It passes down the style, through the tissue bordering the nucellus, to the end of the vascular bundle which reaches the chalaza. Here it branches, one or two short recurved limbs passing outwards towards the surface of the ovule, while the main portion enters the chalaza by the tail of a sterile macrospore, and passing rapidly up leaves it again to approach and become fixed to the embryo-sac. Sooner or later the pollen-tube contracts at a point in the middle of the nucellus, and the upper portion becomes closed off, and separated from the rest. This is evidently due to the fact that the embryo-sac and nucellus grow considerably after the attachment of the pollen-tube to the former, and this causes the rupture.

The oosphere is distinguished from the one or two "neighbouring cells" produced at the same time by its thicker membrane. In some cases it is alone. Several examples have been noted in other Angiosperms of synergidæ clothed with a cellulose membrane, but there is not a single well-authorised case of an *oosphere* invested with a cellulose wall before fertilisation. The appearance of the cell-wall is the result of fertilisation, and is always regarded as an indication of its accomplishment. Treub never saw antipodal cells in *Casuarina*.

Another curious point is that the pollen-tube never joins the macrospore membrane above the insertion of the sexual apparatus as in other Angiosperms, but always at some point more or less distant, sometimes diametrically opposite.

The embryo-sac continues to increase in size, the number of nuclei in the cavity also increases, while the sexual apparatus still remains in the same state, the oosphere keeping the same aspect and dimensions. The pollen-tube never enters the embryo-sac, but the end applied to the wall contains a very distinct protoplasm, and, probably, nuclei.

If we consider as adult the embryo-sac which has reached the dimensions it will keep till the appearance of the embryo, we find

that up to this stage the sexual apparatus remains unchanged. When this stage is reached, the embryo-sac contains a great number of nuclei, while in the dense protoplasm at the summit, endosperm cells begin to be formed round them, and this formation descends gradually to the base till the sac is filled with solid endosperm. Shortly after the appearance of the first cells, development of the embryo commences, by division of what must accordingly be now the oospore. The embryogeny conforms to the ordinary dicotyledonous type, and Treub saw nothing particular to characterise it.

Treub cannot indicate the precise moment of impregnation, not having seen the male nucleus penetrate to the oosphere. The otherwise universal test of the presence of a cell-wall will not apply, for the oosphere of *Casuarina* has a cellulose membrane from its birth, at a time when the pollen-tube has not even entered the nucellus. Another indirect test fails. In Angiosperms carefully studied for this purpose, the synergidæ have generally quite a different appearance before and after fertilisation, and often the fertilised oosphere elongates considerably before the first division proves that it has been fertilised. It is necessary from the position of the pollen-tube that the male nucleus must (1) traverse the membranes of the pollen-tube and embryo-sac, and enter the cavity of the latter; (2) traverse a smaller or greater part of the cavity; (3) penetrate the oosphere from below. Treub thinks fertilisation takes place much later than the time of junction of the pollen-tube and embryo-sac, in fact, the moment before the first endosperm cells appear in the top of the adult sac, and adduces in support the following facts. The pollen-tube remains attached to the embryo-sac; we might expect if fertilisation had taken place at once that the tube would have perished. There is, moreover, a difference in the contents of the tube while the embryo-sac is still growing, and when it is nearly or quite adult. In the latter, the protoplasm has lost its former distinct appearance, and no trace of a nucleus can be seen. The Casuarineæ being tropical and sub-tropical plants experiencing no intervening inclement season, there is no reason for an interval between fertilisation and division of the oospore, such as occurs, for instance, in the Autumn Crocus, where fertilisation takes place in the autumn, but the oospore remains undivided through the winter till the following May. Treub avers, moreover, to have several times seen in adult embryo-sacs in which, according to his view, fertilisation was on the point of taking place, or even had just occurred, a spot in the base of the oosphere where the membrane was very thin and sometimes drawn out to a point which looked as if it were open. He also cites a case where an embryo-sac had undergone considerable development before the pollen-tube had got even close to it.

This view implies that the production of the numerous nuclei in the sac is not a consequence of impregnation as in other Angiosperms, but as independent of it as in Gymnosperms. It is, in fact,

the commencement of a true prothallium. The production of endosperm cells must coincide almost with the moment of impregnation, which would clearly be rendered impossible by an earlier production of cells, considering the path the male nucleus must take. It may be that the pollen-tube when entering the nucellus stimulates the young embryo-sac to assume the state necessary for it to be fertilised later on, but there is a profound difference between mere accessory stimulation and fertilisation. Is it possible to follow the little male nucleus, lost among the numerous nuclei of the large embryo-sac, on its way to the oosphere, and to determine the precise moment when it enters the bottom of the oosphere? The difficulties are all but insurmountable, and we at any rate cannot but agree that Dr. Treub was justified in his determination to put before us the many interesting and unexpected facts he has elucidated without waiting to settle this doubtless very difficult point.

The Casuarineæ are usually placed in that section of Apetalæ which includes also the Cupuliferæ, Myricaceæ, Juglandaceæ, and other families. It is in these that we should expect to trace affinity with the Casuarineæ, but in none is there any indication of the curious structures and events just described, and Treub concludes that the Casuarineæ occupy a quite exceptional place among the Angiosperms.

For the great development of sporogenous tissue (recalling the Cycads and Cupressus) and the large number of macrospores, the greater number of which arrive at the formation of a sexual apparatus, we must seek comparison with the Vascular Cryptogams. The formation of a large number of prothallial nuclei in the fertile macrospore before fertilisation (supposing Treub's view correct as to the moment of impregnation), recalls what passes in a greater degree in the macrospore of Gymnosperms, and indicates an intermediate stage between the latter and the Angiosperms. The origin of the sexual apparatus from a single cell, the similarity in aspect of the "neighbouring cells" of the oosphere to "canal-cells," indicate an homology with the archegonium of Gymnosperms and Vascular Cryptogams, and that the "neighbouring cells" are not comparable with the synergidæ of Angiosperms. Finally, there is the most anomalous mode of entry of the pollen-tube by way of the chalaza, for which Treub suggests the following explanation.

When Angiospermy originated, the micropyle lost its function of conducting the pollen-grains which now germinated, not on the nucellus as in the Gymnosperms, but at a distance, the pollen-tube having to traverse the intervening space. There were two ways in which the pollen-tube might reach the embryo-sac: the one used before by the grain, through the micropyle, the other through the chalaza. The genus *Casuarina* is, as far as we know at present, the only surviving example which chose the latter mode of entry, the rest of the Angiosperms taking the former.

Believing that he has clearly demonstrated that *Casuarina* constitutes the type, and probably the only representative, of a separate class, Treub proposes the following division of Angiosperms :—

| Sub-group Angiosperms. | |
|---|---|
| SUB-DIVISION. | SUB-DIVISION. |
| Chalazogames. | Porogames. |
| CLASS. | CLASSES. |
| Chalazogames. | Monocotyledons ; Dicotyledons. |

This grouping is open to criticism, and we cannot but think that the author has selected the least important difference to characterise his new subdivision ; for the route taken by the pollen-tube is surely of little account provided the macrospore is ultimately reached. Until we have some more definite evidence of the relation in time between impregnation and the formation of the endosperm, we cannot lay much stress upon it for purposes of classification. It is quite possible that fertilisation never occurs, and that the oosphere born with its cell-wall already formed is potentially an oospore. There are cases of apogamy quite as striking in the fungi among the Saprolegnieæ. The fact that nuclei were never distinctly seen in the apex of the pollen-tube points in this direction, as also does the comparatively thick membrane of the oosphere, which would afford considerable resistance to the passage of fertilising material. The most striking fact is the number of the macrospores, and the high development they attain. *Rosa livida*, referred to above, shows an indication of the same, though in a much less degree.

Dr. Treub has certainly made out some points of the highest interest, but hardly sufficient, especially considering the perfect similarity of the embryology with the ordinary dicotyledonous type, to separate the genus *Casuarina* as a distinct subdivision of flowering plants.

A. B. RENDLE.

VII.

# The Naturalist in La Plata.[1]

SELDOM, if ever, have we read with such extreme pleasure and interest any work on the habits and ways of animals in their native state as Mr. W. H. Hudson's "The Naturalist in La Plata," a volume which is in every respect a worthy successor to Mr. Bates's "Naturalist on the Amazons," or Mr. Wallace's "Malay Archipelago." Mr. Hudson is, indeed, in some respects unrivalled as an observer of animate nature, and is equally at home when treating of the ways of large ferocious animals like the puma, or when describing the curious dances of the birds of the Pampas. He has also the rare charm of conveying to his readers the results of his observations in such bright and vivid language as cannot fail to make the volume acceptable to all lovers of nature. Indeed, so striking is his word-painting, that we seem to realise the scenes described, even without the aid of the very excellent figures with which many of them are illustrated.[2]

The greater portion of the work, as we are informed in the preface, has already seen the light in the form of articles in various magazines and journals. This, indeed, would have been apparent of itself, on account of certain repetitions which occur here and there, notably the description of the scent given by the male Pampas deer, in almost identical sentences on pages 16 and 159. The author being essentially an outdoor naturalist, may, perhaps, be excused for not being quite up to date in regard to nomenclature and synonomy. For instance, *Didelphys aurita* (p. 18) is now regarded as identical with *D. marsupialis*, of which *D. azaræ* (p. 102) is only a variety. Then again, the bat alluded to on page 101 as a *Vespertilio* would appear, according to Dr. Dobson, to be an *Atalapha*. There are, moreover, a few misprints, such as *auritur* for *aurita* (p. 18), *Porphyriops* for *Porphyrio* (p. 20), and over-bird for oven-bird, which might have been avoided by a little more care in proof-reading. These are but slight blemishes, and any inaccuracy in the proper names of the opossums of the Pampas is largely discounted by the

[1] THE NATURALIST IN LA PLATA. By W. H. Hudson. London: Chapman and Hall, 1892. 8vo. Pp. 388. Illustrated. Price 16s.

[2] We are indebted to the publishers for the opportunity of presenting samples of the illustrations to our readers.

interesting observations on the occurrence of such animals in those treeless wastes.

Passing on to a brief survey of the work, we find in the first chapter an excellent description of the Pampas and its inhabitants —both feathered, mailed, and furred. Among the latter, considerable interest attaches to the account of the large Rodent Coypu, and especially its sudden increase and change of habits when protected by law, and its equally sudden destruction by a pestilence which rendered the species well-nigh extinct. A striking illustration is given of a female coypu swimming with its young. Later on (p. 23), we notice that the author waxes very wroth with those who advocate a northern origin for the life of the globe, and at the same time expresses his belief in the existence of a varied bird-fauna, and perhaps also of mammals, in the unexplored antarctic regions. We fear, however, that as regards mammals at least this sanguine view

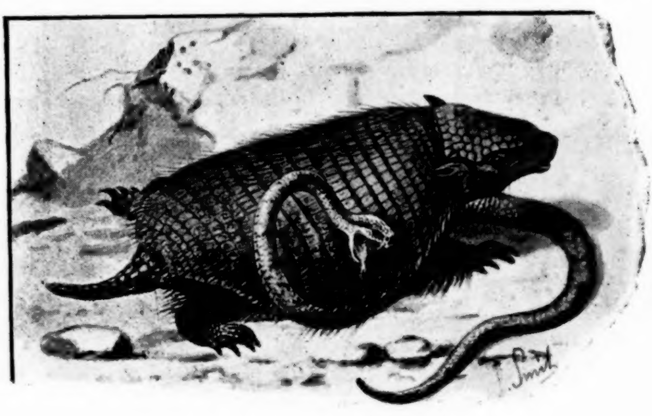

FIG. 1.—Three-banded Armadillo killing Snake.

is not likely to be realised. Near the end of this chapter the author is at his best in his description of the Rhea, or American ostrich, and we regret to learn that this splendid bird, with some other feathered inhabitants of the Pampas, is likely ere long to share the same fate as the bison of the prairies of the northern half of the continent.

In the second chapter we have a full biography of the puma, which, far from being the cowardly creature generally reported, is described as being really bold and courageous. Curiously enough, it appears to be now well ascertained that the puma in South America will not only never attack man, but will not even defend itself against him. It is new to us that pumas are such deadly enemies to horses as to render their existence impossible in regions where the former abound; and it is accordingly suggested that we may here have an

adequate cause for the extinction of the original American horses of which the remains are found in the superficial deposits and caves. Mr. Hudson gives full credit to the statement of the occurrence of the puma in Tierra del Fuego.

In the fourth chapter, entitled "Some curious Animal Weapons," we desire to draw particular attention to certain very interesting observations regarding the hairy armadillo. This animal (of which we reproduce Mr. Hudson's figure) is stated to have a good chance of surviving all the other members of the group (which are rapidly diminishing), owing to the omnivorous habits it has acquired, and the assumption of a partially nocturnal mode of life. The curious manner in which this armadillo burrows after its prey is graphically described, and the illustration reproduced exhibits the mode in which it actually saws the flesh of unfortunate snakes by means of the sharp edges of its carapace.

Omitting the interesting chapter on "Fear in Birds and

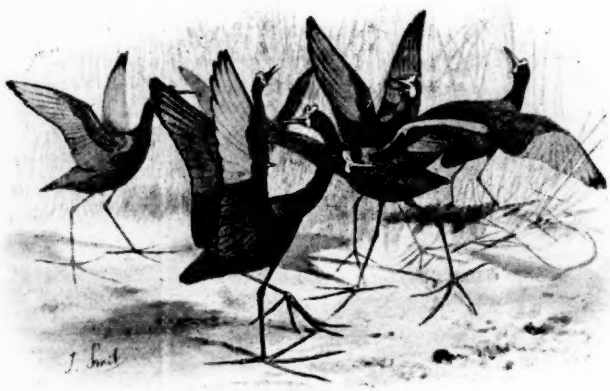

Fig. 2.—Wing-display of Jacanas.

Parental Instinct," we pass on to the seventh, where we find much entertaining reading as to the terrible effects of the secretion from which that noisome creature, the skunk, derives its name; and we confess that until we read the anecdote detailed on pp. 117, 118, we had no conception how persistent and how effectual is even one drop of that fluid. After five chapters devoted to Insects—among which the one on Dragon-fly-storms will be found especially interesting —we have in the fifteenth an account of the death-feigning instinct, which curious mode of protection is developed in such widely different animals as foxes, opossums, and tinamus. The sixteenth chapter is devoted to Humming-birds, where we find it remarked that, after exhausting his powers of admiration on their gorgeous colouring and strange modifications of form, the naturalist finds little scope for

observation among these birds owing to the similarity and mechanical nature of their habits. This chapter is illustrated by a marvellous figure of *Loddigesia*—the strangest in plumage of the whole group, and which was long known only by a single example from Peru, until re-discovered by Stolzmann in 1880. In the chapters on the Horned Screamer, and the Woodhewers (*Dendrocolaptidæ*) space only permits of reference to the extraordinary range of variation presented by the beaks of different genera of the latter, as exemplified by the illustration on page 239.

Perhaps the most attractive chapter in the whole volume is the one entitled "Music and Dancing in Nature," where it is shown how universal is rejoicing in one form or another among all animate nature. First, we have reference to the solitary dance of the gorgeous "cock-of-the-rock," followed by accounts of the social

FIG. 3.—Viscachas at Home.

dances of various other birds, among which those of the rails and their allies appear most remarkable. Among these, the author illustrates the performances of the ypecaha rails and the long-limbed jacanas by excellent figures, one of which we reproduce. In the jacanas, the dance appears designed to exhibit the concealed beauty of the silky greenish-golden wing-coverts. These birds, writes Mr. Hudson, "go singly or in pairs, and a dozen or fifteen individuals may be found in a marshy place feeding within sight of each other. Occasionally, in response to a note of invitation, they all in a moment leave off feeding and fly to one spot, and, forming a close cluster, and emitting short, excited, rapidly repeated notes, display their wings like beautiful flags grouped loosely together; some hold the wings up vertically and motionless, others, half open and vibrating rapidly. while still others wave them up and down with a slow

measured motion." Still more extraordinary is, however, the performance of the spur-winged lapwings, which live in pairs. One such pair may frequently be visited by a single bird from another pair, upon which the stranger takes the lead in a triangular kind of dance, of which the description is so ludicrous that we must refer the reader to the original.

The twentieth chapter is a long and interesting one on the biography of that curious social rodent, the Vizcacha, formerly the commonest of all the mammals of the Pampas. Recently, however, a war of extermination has been waged against these little creatures by the landowners—presumably on account of the harm done by their warrens, the viscachera of the natives—which has been only too successful from their point of view. Mr. Hudson's account of these animals, when in their full development, should thus be of especial value to naturalists; and his excellent illustration (reproduced) gives a good idea of the general appearance of the "viscachera" when fully inhabited.

In the chapter on the guanaco, or huanaco—one of the llamas—the author fully confirms Darwin's account of its unique and inexplicable habit of seeking a spot crowded with the bones of its predecessors when about to die. This habit, says our author, seems "less like an instinct of one of the inferior creatures than the superstitious observance of human beings, who have knowledge of death, and believe in a continued existence after dissolution."

Such are a few of what strike us as the more interesting points in Mr. Hudson's volume. When, however, he has to deal with a work which, like that before us, is teeming with interest on almost every page, the reviewer's task is one of difficulty from an *embarras de richesses*, and we can, therefore, do no more than heartily commend "The Naturalist in La Plata" to the attention of all our readers.

R. Lydekker.

# SOME NEW BOOKS.

Outlines of Zoology. By J. Arthur Thomson, M.A., F.R.S.E. 8vo. Pp. 641. With 32 full-page Illustrations. Edinburgh: Young J. Pentland, 1892. Price 12s. 6d.

The number of text-books of Zoology increases rapidly year by year. Only a very short time back the difficulty was to find a book of any kind, written in English, which gave an adequate account of general Zoology and the Comparative Anatomy of Invertebrates as well as Vertebrates. Nowadays, the difficulties are just as great, not on account of the paucity of books, but by reason of their very large number, good, bad, and indifferent—particularly of the last two categories. The struggle for existence among these text-books must be very keen, especially among those which are merely cram-books for examinations of the universities of London and other places. On the whole, the more favourable varieties appear to thrive, though, unfortunately, the rest do not become extinct.

The problem which has to be solved by anyone who writes a book of this kind at present is how to pay due attention to the "types" without producing a mere cram-book. An elementary text-book, in which these types were treated with too scant courtesy, would die a rapid death. Mr. Arthur Thomson, in the manual before us, seems to have succeeded in striking the mean between a too exaggerated respect for the type system and a too pronounced contempt for it. Those animals which find a place in the schedules of universities are for the most part carefully described. We are glad to notice that 12½ pages are devoted to an account of the structure and development of that important creature, the earthworm; the leech, however, only gets 5½, perhaps rather too scanty an allowance.

Besides these descriptions of representatives of the different groups of the animal kingdom, there are good general summaries of the characters of the groups themselves. The Mollusca will serve to illustrate the method adopted. First of all the three main divisions, *i.e.*, Lamellibranchiata, Gasteropoda, and Cephalopoda, are mentioned, with a remark enclosed in square brackets to the effect that *Dentalium* is to be placed in a separate class, and that some authorities admit a few other small classes. Then follow the "General Characteristics of Mollusca," and a tabular classification. After this are "General Notes on Molluscs," containing a few words on the signification of the term "Mollusca" as used in the classificatory schemes of Linnæus and Cuvier; some additional observations upon the structure and growth of the shell; and some remarks upon the larval forms. Each class is then treated in a somewhat similar fashion, the general characters preceding the detailed description of the type, and a classification following. Although this is the general plan upon which the author proceeds, the treatment of each group is not detail for detail the same. This,

however, is no defect; on the contrary, the variations make the book more interesting. A dull monotony is avoided in this way, and also by a frequent change of type, and the interpolation of tabular comparisons of animals. The style, moreover, is attractive—a state of affairs not often found in text-books.

Mr. Thomson retains the division Worms, though he distinctly states that "the animals included . . . form a heterogeneous mob, with little in common." The expression "Worms," when used, is almost invariably written between inverted commas, which further emphasises this perfectly just objection to the retention of such a group.

Two hundred and thirty-four pages out of a total of six hundred and four are devoted to the Vertebrata, not including *Amphioxus*, *Balanoglossus*, and the Tunicates. This seems to us to be rather out of proportion, though in most text-books the Vertebrata claim an equally large share of the author's attention. One of the few books in which they are treated justly, but with no favour, is Professor Gegenbaur's well-known work.

Nearly every page has interesting notes about the habits of the animals under consideration. Thus, in describing the Spiders, Mr. Thomson does not forget that their webs are rivalled in fineness by Mr. Boys' quartz fibres; and he gives some account of the remarkable observations on the "courtship" of the creatures by Mr. and Mrs. Peckham, partly because "it affords a pleasant interlude in our systematic survey," but also as a peg whereon to hang comments on the theory of "Sexual Selection." Most, if not all, of the current generalisations of Biology and the theories which have been put forward for their explanation are treated of; and some of these are interspersed among the chapters upon the various groups, as in the instance mentioned. The general facts of Physiology, Histology, &c., occupy the first ninety pages of the book. Evolution has a short chapter of nine pages to itself.

Though the theories most in vogue are impartially stated, we notice frequent indications of the author's own views. These are by no means obtruded on the reader; indeed, the faith of the student in the orthodox theories will not be rudely shaken, even if a little doubt is occasionally infused into the complacent attitude produced by the teaching of most professors and lecturers. In treating of Sexual Selection, Mr. Thomson is inclined to lay more stress upon "the fundamental qualities of maleness and femaleness," than any selection by the female, a position taken up by Professor Geddes and himself in their "Evolution of Sex." He remarks that "it is difficult to understand how this characteristic smallness [of the males], though perhaps advantageous and likely to be favoured by natural selection, could be entailed on the male offspring only." Much harder to understand is sexual trimorphism, such as occurs in certain butterflies. We have cases where an insect has two kinds of females, one more or less like the male, the other "mimicking" another butterfly, supposed to be protected by a disagreeable taste.

The book is, in fact, to be decidedly recommended, not only to students preparing for examinations, but to persons already possessing a certain amount of knowledge of the subject, who desire to have the main facts of Zoology compressed into a single thoroughly readable volume. The only parts of the book with which we find fault are the illustrations; and this not on account of want of clearness, but from their inartistic style. They are roughly executed outline drawings arranged on thirty-two plates.

Catalogue of the Psittaci, or Parrots, in the Collection of the British Museum. By T. Salvadori. Pp. xvii., 658. Pls. xviii. London British Museum, 1891 (1892).

The twentieth volume of the British Museum Catalogue of Birds, a Monograph of the Parrots, by Count Salvadori, has recently been issued. The collection of Parrots in the British Museum is not so extensive or so nearly complete as that of the orders treated in the preceding volumes; and the Trustees have thus been fortunate in securing the services of an eminent specialist who is well acquainted with the genera and species in foreign collections that supplement the one on which the volume before us is particularly based. As the result of his researches, Count Salvadori presents ornithologists with a valuable work of reference, full of original matter, and admirably illustrated by a series of beautiful plates by Keulemans. At the same time, the author regrets his investigations add very little to previous knowledge of the mutual or phylogenetic relations of the various groups and families dealt with; and no satisfactory information on this subject can be expected until the anatomical work of Garrod is resumed and much extended.

There seems to be no longer any doubt that the Parrots are more closely related to the Owls than to the diurnal Birds of Prey. They form the Order Psittaci of modern classifications, and at the present time they are chiefly tropical birds, though some species extend as far as 42° N. lat. and 55° S. lat. They are specially distinguished from their allies by the well-known "zygodactyle" form of their feet (*i.e.*, two toes turned forwards, two backwards) and the extremely short, stout, strongly hooked character of the bill, which has a cere (frequently feathered) at its base, as in birds of prey. The upper jaw is moveable, being hinged on the forehead; and the tongue is thick and fleshy, sometimes fringed. The ring of bone round the cavity for the eye is often complete, and the septum between the right and left cavities of the nose extensively ossified. The feathers have aftershafts; the young are hatched helpless, without down or feathers, which successively appear. The eggs are white.

According to Count Salvadori, Parrots may be arranged in six families, three of which have the oral surface of the hook of the bill smooth, while the remaining three exhibit a file-like roughness of this surface. The first three families are those of the Nestoridæ (from New Zealand), the Loriidæ or "Lories" (from the Australian Region, except New Zealand), and the Cyclopsittacidæ (from the Austro-Malayan sub-region). These are mutually distinguished by the characters of the tongue and bill. The second three families, with file-like bill, are the Cacatuidæ or "Cockatoos" (ranging over the Australian Region and the Philippine Islands), the Psittacidæ, or "Macaws," "Parakeets," and true short-tailed "Parrots" (distributed throughout the intertropical regions), and the Stringopidæ (found only in New Zealand). Of these, the first two families have a complete sternum, while the Ground Parrot *Stringops*, as might be expected, possesses a sternum with a rudimentary keel. The Cockatoos have a crest of feathers on the head, and a complete orbital ring, and thus differ from the Macaws, Parakeets, and Parrots proper.

The detailed diagnoses of nearly 500 species are given by Count Salvadori, and 13 of the forms recognised are new.

Histoire physique, naturelle et politique de Madagascar. By Alfred Grandidier.—Volume xvi. Histoire naturelle des Poissons. By Dr. H. E. Sauvage. 4to. Pp 543. With Altas of 63 plates. Paris: 1891.

This new instalment of M. Grandidier's admirable work, although bearing the date 1891 on its title page, was not received in this country until the end of last month. Most of the plates, without letterpress, had, however, been previously issued, and were reported in the *Zoological Record* for 1888.

Dr. Sauvage's work will prove of much service to the student of the fishes of the Indian Ocean, as the author, from the position he has held for several years in the Paris Museum, has had every facility to compare the types of the numerous species so inadequately described by Cuvier and Valenciennes, Liénard, and Guichenot, with the descriptions of modern ichthyologists. The figures accompanying his volume, although not comparable from an artistic point of view with those of the companion volumes on Mammals and Birds by such accomplished draftsmen as Messrs. Bocourt and Keulemans, are executed with care, and mostly from type specimens ; they thus afford another source of welcome information.

For the student of geographical distribution, the present work also fails to compare in interest with its predecessors in the same series, through no fault of the author, but from the fact that the freshwater fish-fauna of Madagascar is a very poor one. In fact, apart from the very pronounced negative features of their fauna, the Chromides form the only group calling for special notice. This family, which appeared towards the close of the Cretaceous period in North America, is now confined to Central and South America, Africa and the neighbouring parts of Asia, and Madagascar. A few years ago, only two or three species were known from the latter part of the world ; eight are now on record, referable to four genera, one of which approaches an African type, the three others showing decided affinity to forms now living in tropical America. The fish-fauna, therefore, poor as it is, affords further confirmation of the views held as to the relation of various other groups of animals, reptiles in particular, to South American types.

The negative features are particularly striking in the absence of Cyprinoids, so abundant in Africa, and Characinoids, a large group special to Africa and America.

Only two species are given as new in this work, one of which, described and figured as *Eleotris sikoræ*, is clearly an *Atherina*. Such an error seems inexcusable, as these two genera, belonging to widely different families, have scarcely anything in common. We are sorry to say this is not the only example of carelessness, *Hypoptychus dybowskii*, an Apodal Gadoid, being figured under the name of *Eleotris tohizonæ*, Stdr., from the mere fact that in Steindachner's original paper in the *Sitzungsberichte* of the Vienna Academy for 1880 a transposition of numbers took place on Pl. II.

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The Oak: A Popular Introduction to Forest-Botany. By H. Marshall Ward, M.A., F.R.S. 8vo. Pp. 175. London: Kegan Paul, Trench, Trübner & Co., 1892. Price 2s. 6d.

Professor Marshall Ward's new work forms the third volume of the series of "Modern Science," edited by Sir John Lubbock. Starting with the acorn, the author claims to give "a short account of what is most worth attention in the anatomy and physiology of the

oak as a forest tree which has been so thoroughly investigated that we may confidently accept it as typical." If the reader is absolutely ignorant of scientific terminology, he will meet occasional stumbling-blocks, but granted a slight knowledge he will find the book an interesting and, for its size, a most thorough exposition of what is known about this familiar tree.

Chapter I. is introductory. Chapter II. deals with the acorn and the germination of the seed, and includes, under an account of the internal structure of the embryo, a clear definition of the cell as a member of a tissue, that is, as part of a whole and separated from its neighbour by a wall, which is a single structure common to both, and not the result of the juxtaposition of two separate walls. Chapters III.—VI. treat of the seedling and young plant. In Chapter III. the structure and properties of the young root are considered. There is a good explanation of the gradual development of the parts in acropetal succession, and a description of the various expressions of irritability to external stimuli, and their use to the organ in functioning as a holdfast and a collector of nutriment from the soil.

The following three chapters contain an account of the shoot-system, that is, all the structures developed from the plumule, or bud of the embryo. The arrangement of the skeleton of vascular bundles is first described and the longitudinal course of the latter illustrated. A chapter is devoted to the general outline of the stem, and excellent figures of sections in different planes have been borrowed from Hartig and Kny, though, unfortunately, the lettering by which the parts are indicated is so broken and indistinct as to be often quite illegible. If good figures are ready to hand, by all means let them be used; but surely there should be some method by which new lettering can be introduced, for the parts, especially in longitudinal sections of vascular tissue, are not always evident at first sight. The same remark applies to some similar figures in Chapter VIII., and also to a revival from Eichler's *Blüthendiagramme* in Chapter IX., where after looking in vain for *x* we find it to be an unknown quantity, and its place taken by a broken-down *z*.

The buds and leaves are next described; and there is a brief and simple account of the process of transpiration and the function of the green colouring matter, with its relations to sunlight and the assimilation of food. Here, as elsewhere, theory is avoided, the author confining himself to mere statement of the physiological facts as accounting for the various structures and tissue arrangement.

In Chapters VII., VIII., and IX., headed "The Tree," the adult root and shoot systems are considered with their mode of growth in thickness and the consequent changes leading to the formation of cork and bark. The interesting case of Symbiosis of the root and a fungus, forming the *Mycorhiza*, is noted and figured, and an explanation suggested. In Chapter IX. we are brought back again to the acorn, by an account of the inflorescence, flower, and fruit.

The next chapter is technical at times, giving in a short space a concise account of the structure and industrial peculiarities of oak-timber. The cultivation and the diseases and injuries to which the tree is subject form the matter of Chapter XI.; and Professor Ward must have found it difficult to confine his remarks on this head to a dozen pages, about half of which are occupied by some capital figures.

Finally, the relationships of the oak and its distribution in space and time are disposed of in less than five pages. The genus *Quercus* is of interest, in containing numerous closely connected varieties, a

fact which led De Candolle to regard it as a series of incipient species; for if the connecting forms died out, leaving some varieties more isolated than at present, the latter would be at once ranked as species. From the evidence of their fossil remains, together with the facts of their present distribution, "it is at least exceedingly probable that the European oaks, including our English oak, came into existence somewhere in the East, and that, after spreading from Asia towards the West, they are now slowly retreating before competing forms—*e.g.*, the beech."

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A Short and Concise Account of the Eruptive Phenomena and Geology of Monte Somma and Vesuvius, in Explanation of the Great Geological Map of that Volcano constructed during the Years 1880 to 1888. By H. J. Johnston-Lavis, M.D. Small 8vo. Pp. 21. London: George Philip and Son, 1891.

Probably every geologist who has toiled over the rugged surface of a Vesuvian lava stream, or has tried to thread his way through the tortuous paths between the vineyards of its lower slopes, has felt the need of a geological map of the volcano and its immediate environs. Perplexed, moreover, by the intricate mingling of ashes, tuffs, lavas, and dykes belonging to different periods and eruptions, he has probably also longed for a work that would be more detailed than Lobley's and more modern than Phillips'. One of these desiderata has now been supplied by Dr. Johnston-Lavis's splendid large-scale geological map, and the other is promised shortly as a monograph of the mountain of which the pamphlet named above is a preliminary sketch. The map is on a scale of 1 to 10,000 (6⅓ inches to the mile): it is issued in sheets, each measuring 30 inches by 20. It is well printed and coloured, and its topography is more accurate than that of the Italian map on which it seems to be based. The colouring adopted contains some novel methods to express the slight variations in the nature of the soil which cause so marked a difference in its agricultural value. To assist reference from the monograph, the author has called several previously unnamed valleys after geologists who have worked on Vesuvius. Exact reference to the numerous dykes on the wall of the Atrio are now possible, as they have been marked by the great white numbers which tourists on the summit of the crater generally seem to mistake for advertisements. In the pamphlet accompanying the map, Dr. Johnston-Lavis gives a short sketch of the history of the volcano, and this he divides into four eras and nine phases, of which the first six were prehistoric. In the first era Vesuvius was an island, and probably ejected lavas of a more basic type than any formed in later times, and from which leucite was absent. In the second era the great mass of lavas, scorias, and ashes which now form the lofty precipitous wall overhanging the Atrio del Cavallo were produced. The third era commenced by a long period of inactivity, and ended by an explosive eruption, after which there was a series of eruptions, with periods of repose. The first historic, or the Plinian eruption of A.D. 79, occurred in this era; it destroyed Monte Somma and began to build the existing cone of Vesuvius a little to the south of the original centre of eruption. The last era began with the terrible eruption of 1631. A short account is given of the surface erosion, of which that performed by the *moyas* or mud streams of the northern slopes of Monte Somma is the most distinctive feature.

# NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

THE new extension of the buildings of the University College, Bristol, is rapidly progressing, and will probably be ready for occupation by the Medical School in October next. A similar extension to accommodate the Engineering School is contemplated

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BY the retirement of Dr. W. C. Williamson, F.R.S., from its chair of Botany, the Owens College, Manchester, loses the last of the original professorial staft appointed on its foundation in 1851. At first Professor of Natural History, Dr. Williamson was gradually relieved of his extensive duties by the growth and subdivision of the Biological and Geological faculties of the College, until in the end he was enabled to devote himself entirely to Botany, aided by the services of an Assistant-Lecturer. A farewell address was presented to Professor Williamson by Principal Ward on February 13, in the presence of a large gathering of colleagues and friends; and he has now removed his residence to London. The Professorship thus vacated has been filled by the appointment of Mr. F. E. Weiss, for some time Assistant-Professor of Botany in University College, London.

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THE British exhibit in the Botanical Gallery at the British Museum is steadily progressing. For more than two years the ferns and flowering plants of Great Britain, arranged according to Bentham's Handbook, have been exposed on sheets of stiff card, framed and protected by glass. The description is placed beneath each plant, so that collectors can compare their own specimens with the descriptions and specimens exhibited. The latter have been selected with a view to illustrate the usual form of the plant by an average-sized specimen; the rarer and often merely local forms are not included, and for these and the critical varieties, which are beyond the scope of the ordinary field botanist, the British Herbarium must be consulted. The mosses have since been added, arranged by Hobkirk's Synopsis. Descriptions of the species are included, and also, in the case of the smaller ones, a magnified coloured drawing of the whole plant and the fruit. Within the last month another addition has been made, the first instalment of a complete series of coloured drawings of the British Basidiomycetous fungi having been placed at the service of the public, in a manner uniform with the exhibits of the higher sections of the vegetable kingdom. The drawings at present shown comprise the Agarics, and number nearly 600. Mr. Worthington G. Smith was commissioned early last year by the trustees, on the recommendation of Mr. Carruthers, the keeper of the department, to make drawings of all the British Basidiomycetes for exhibition in the public gallery. Mr. Smith has lately revised Berkeley's outlines, and the series when complete will represent each of the two thousand odd species now included in this group. The drawings are life-size, but magnified representations of the smaller ones are also given. The exhibit is a most attractive one, and though only about one-fourth of the whole are as yet shown, the public are evidently already surprised to find so many different kinds of "mushrooms and toadstools," the collective name for the group with the non-scientific.

PARIS may well be claimed as the birth-place of palæontology, and we sympathise with the present eminent professor at the Jardin des Plantes, M. Albert Gaudry, when he pleads for the due recognition of this branch of science in the Paris Museum of Natural History. As the Professor remarks in the *Revue Scientifique* of February 20, the building at the Jardin des Plantes forty years ago was the finest museum of Natural History in the world; whereas to-day, except in the new galleries for Zoology, it is far behind most national institutions of this character. The palæontological collections are arranged for the most part in a temporary shed and in small rooms, with inconvenient cases. In many departments the series of specimens is unique, and it would be more than a national calamity if, by any accident, under existing circumstances, they should be damaged or destroyed. M. Gaudry institutes a comparison between the liberality of the British Government and that of the French Government in providing for the custody of its Natural History Museum, and we hope his claim for further support from the French Treasury will meet with the attention it deserves.

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THE Manchester Museum, Owens College, is issuing a series of small handbooks. The "General Guide," by Mr. W. E. Hoyle, is based on the plan of the British Museum Guide Books, well illustrated, and published at the low price of twopence. It will suffice admirably for ordinary visitors, and is in nearly all respects well up to date. We would only point out that the "giant Ant-eater" (*Macrotherium*) of the "Mid-Meiocene" age was several years ago proved to be a myth, and it is thus misleading to reproduce Dawkins' outline restoration of the animal. Professor Marshall's "Outline Classification of the Animal Kingdom," price one penny, is much less entertaining, being a mere list of names of groups, intended as an index for students. The same Professor's "Descriptive Catalogue of the Embryological Models," price one shilling, is a most valuable little handbook, and deserves to find a place in the library of every zoologist who wants a concise epitome of the stages in the development of some of the leading types of animal life. We presume it contains something of the essence of Professor Marshall's forthcoming Manual of Embryology.

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THE usual series of Museum Lectures at the Owens College, Manchester, is in progress this session. In addition to the short courses by the Professors of Zoology, Botany, Geology, and Mineralogy, three free holiday lectures are undertaken by Mr. W. E. Hoyle, Keeper of the Museum. On the morning of December 26th, Mr. Hoyle addressed a large audience, chiefly children, on "Unnatural History." The subjects announced for Easter Monday and Whit Monday respectively are "Strange Fishes" and "Elephants (ancient and modern)."

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THE annual meeting of subscribers to the Dorset County Museum was held on January 20th last, when the chairman of the Council, Mr. J. C. Mansel-Pleydell, F.L.S., contributed a short summary of progress. One of the latest additions to the museum is a case illustrating, both with specimens and photographs, Mr. Mansel-Pleydell's discovery of the Pliocene elephant (*Elephas meridionalis*) at Dewlish, Dorset.

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AN important extension of the Leicester Town Museum has just been completed, and the collections are now being re-arranged in accordance with modern methods. A convenient laboratory and workshop has been provided for the Curator and his assistants beneath a new room specially built for the Leicester Literary and Philosophical Society.

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AT the meeting of the Liverpool City Council on March 2, the retirement of Mr. T. J. Moore, A.L.S., from the curatorship of the Free Public Museum was announced. Mr. Moore's term of service extends over nearly forty years, and his many friends will regret to learn that failing health prevents his continuing an active interest in

the cause of Natural Science for which he has done so much. Mr. Moore was awarded a well-earned annuity, and it is hoped that, by an arrangement with the Derby trustees, he will still be able to undertake the duties of Consulting Curator, and thus prevent the necessity of appointing a successor for the present. We are glad to add that, notwithstanding his advanced age, the Rev. H. H. Higgins is still able to take an active part in the affairs of the Museum, and has lately obtained several important acquisitions.

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We also regret to announce the retirement of Major John Plant, F.G.S., who has occupied the position of Curator and Chief Librarian of the Peel Park Museum, Salford, since its foundation in 1849. Under Major Plant's direction this institution has gradually developed into one of the principal attractions of the busy centre to which it belongs. The library now contains some 60,000 volumes, in place of the 5,000 with which it started, and is provided with a handsome reading room. The rooms in which the scientific exhibits are displayed are numerous and well adapted to their purpose; while the art galleries include the great Langworthy Gallery, occupied with marble statues and fine oil paintings of the modern English and French schools. Apart from his official work, Major Plant has taken an active part in the proceedings of the Manchester Geological Society and other local institutions; and, by his retirement to Anglesey, a leading figure will be removed from Manchester scientific circles. He is succeeded at Peel Park by Mr. B. H. Mullen, M.A., late of the Science and Art Museum, Dublin.

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We have received a brief report of the work of the Essex and Chelmsford Museum for 1891. A successful effort is being made to establish this institution as a centre of intellectual activity, not only for Chelmsford, but also for the whole of the county. Its work is chiefly in the direction of advanced teaching, but the practical lessons learned in the Field Lectures on Geology and Botany, by Mr. W. H. Dalton and Dr. J. E. Taylor, are sure to tend to the progress of Natural History research in the county.

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Mr. Arthur Smith Woodward has been appointed Assistant-Keeper of the Geological Department of the British Museum, in succession to Mr. R. Etheridge, F.R.S.

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Mr. J. Scott Keltie has succeeded the late Mr. H. W. Bates as Assistant Secretary of the Royal Geographical Society.

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The volume of the Palæontographical Society's Monographs for 1891 has just been issued. It comprises continuations of the Monographs on Jurassic Gasteropoda, by Mr. W. H. Hudleston, F.R.S.; on Inferior Oolite Ammonites, by Mr. S. S. Buckman; and on the Devonian Fauna of the South of England, by Rev. G. F. Whidborne. The imposing list of memoirs "in preparation" and "in course of publication," appears as usual; but we have good reason to believe that the large majority of these are no further advanced than they were many years ago when the titles were first announced. As, however, at least half the names on the list of the Society's Council are quite unknown in the sphere of Palæontological Research, we must not expect too much.

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In the last number of the *Proceedings of the Royal Society of Edinburgh* (vol. xviii., pp. 299–302), the Prince of Monaco gives an interesting brief account of his new yacht, the "Princesse Alice," in which he hopes to continue his researches in Oceanography and Marine Biology.

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The local use of various Building-stones formed the subject of the Presidential Address to the Rochester Naturalists' Club, by the Rev. G. M. Livett (*Rochester Naturalist*, vol. ii., 1891, pp. 33–46). Noting first the use of Greywethers in the construction of cromlechs, such as Kit's Coty House, he proceeds to call attention to

the use, by the Romans, Saxons, and early Normans of calcareous tufa or travertine. There are records of tufa having been quarried in Kent, but the amount yielded is not likely to have been great. It is probable that the Romans, and also the Normans, imported the rock; but both Saxons and early Normans seem to have quarried a good deal of the material from Roman buildings. Tufa was used in the piers and attached shafts of the crypt of Rochester Cathedral. The successive use of other stones, such as the Caen stone, Purbeck and Sussex Marbles, Chalk, Upper Greensand, and Kentish Rag, are noted with especial reference to their employment in different parts of Rochester Cathedral. One other rock is mentioned, and that is a beautiful stalagmitic rock, of which shafts still remain in the ruined chapter-house of Rochester. It is pointed out that the chapter-house was built by Ernulf, Bishop from 1118 to 1124, and that the same stone was used at Canterbury, where Ernulf was previously Prior, and also at Peterborough, where he was Abbot. This stone was probably imported; but it is not known from whence.

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The Yorkshire Geological and Polytechnic Society has just issued its *Proceedings* for 1891, being the first part of Vol. XII., comprising 130 pages, with two plates of fossils and two meteorological tables. There are seven papers specially relating to the county, namely: (i.) On the present state of our knowledge of the Yorkshire Calamitæ, by Thomas Hick; (ii.) The mode of deposition and properties of the Carboniferous strata of Leeds and its immediate suburbs, by B. Holgate; (iii.) Evidence of Glacial action near Leeds, by James E. Bedford; (iv.) On a Permian Conglomerate Bed at Markington, by Rev. J. Stanley Tute; (v.) Exploration of the Elbolton Cave, by Rev. E. Jones; and two meteorological papers, one (vi.) by R. Reynolds, the other (vii.) by J. McLandesborough and A. E. Preston. Among other papers Mr. C. E. De Rance contributes a long and statistical account of the water-bearing strata and underground waters of Lincolnshire. There are also four general palæontological contributions, namely: (i.) The Hybodont and Cestraciont Sharks of the Cretaceous Period, by A. Smith Woodward, with two plates; (ii.) Notes on some new or but little known Eocene Polyzoa, by G. R. Vine; (iii.) British Palæozoic Ctenostomatous Polyzoa, by G. R. Vine, with two plates; and (iv.) On the affinity of *Dadoxylon* to *Cordaites*, by James Spencer. A good bibliography of geological papers relating to Yorkshire during 1889-90 is added by the Editor, Mr. James W. Davis.

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The subject of the Kentish coalfield was again brought before the Manchester Geological Society by Professor Boyd Dawkins on January 29, and specimens of the coal obtained from the Dover boring were exhibited. 762 feet of Coal-measures have now been pierced, with an aggregate thickness of more than 17 feet of coal in nine separate seams, mostly workable. Seam No. 1 (2 ft. 6 in.) occurs at a depth of 1,140 ft.; and seam No. 9 (1 ft. 8 in.) was met with at a depth of 1,875 ft. Arrangements for the sinking of a shaft are now in progress. With regard to the rumoured discovery of coal in Northamptonshire, we have the authority of Mr. Beeby Thompson for saying that true Coal-measures have not been reached by any boring at present made in the county.

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The *Report and Proceedings of the Belfast Natural History and Philosophical Society*, Session 1890-91, just issued, does not contain any original contributions to Natural Science, except a brief record of a local geological section exposing a basalt dyke. The Committee for recording the Fauna of Ulster report good progress in their work.

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The second part of the *Journal of the Institute of Jamaica*, issued in February, contains much news of local interest, but few contributions to the general advancement of Natural Science. In the reports of meetings, Mr. John Stuart comments favourably on the work of the temporary Biological Station established by the Johns

Hopkins University last summer at Port Henderson, and makes another communication on "Some Physiographical Features of Jamaica produced by the agency of Water." Among the scientific papers Mr. T. D. A. Cockerell publishes a technical "First Contribution to the Entomology of Bath, Jamaica"; and there are shorter notes on entomological subjects.

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We are glad to welcome the *First Report of the Southport Society of Natural Science*, for 1890-91. The Society, as we note from Dr. Vernon's Presidential Address, was inaugurated in November, 1890, and has already done some valuable local work. The Report contains the President's Address on the Material and Educational Utility of Natural Science; Problems in the Geology of the Neighbourhood of Southport, by E. Dickson, F.G.S.; general reports of meetings, and a list of members. It concludes with an appendix, consisting of three important Reports as follow:—A List of the Mollusca of Southport and District, by G. W. Chaster, M.R.C.S.; Botany of the Southport Society of Natural Science District, by Henry Ball; and a Report upon the Foraminifera of the Southport Society of Natural Science District, by G. W. Chaster. The last report is enriched by a carefully drawn plate, and contains facts and observations of considerable interest.

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The fourth annual meeting of the Australasian Association for the Advancement of Science was held at Hobart Town, Tasmania, early in January last. In his Presidential Address, Sir Robert Hamilton made an eloquent appeal to the people of Australasia to foster the growth of science and scientific methods in the Colonies. In Natural Science, Professor T. W. E. David presided over the section for Geology and Palæontology, and Professor Baldwin Spencer over that of Biology; while Captain Pasco, R.N., occupied the chair in Section E (Geography), and the Rev. Lorimer Fison presided over the Anthropologists in Section G. Professor David addressed the Geologists on Volcanic Action in Eastern Australia and Tasmania. So far as known, the facts indicate that volcanic action in these regions has occurred most frequently after periods of continued subsidence culminating in a re-elevation of the land by way of compensation. It appears that subsidence preceding volcanic activity is often due to the pressure of the accumulation of thick masses of sediment. Mr. Clunies Ross contributed papers on Coral Reefs and on *Lepidodendron* from New South Wales. The value of photography in geological work was also discussed, and there were many minor papers. In his Presidential Address, Professor Baldwin Spencer treated of the origin and development of the Fauna of Tasmania, briefly describing its present characters. Professor F. W. Hutton reiterated his views as to the derivation of the flightless birds of Australasia from flying birds related to the Tinamus of South and Central America; and there were many other papers, both on Zoology and Botany, chiefly dealing with Australasian subjects. Captain Pasco's address to the Geographical Section included a history of some of the earliest explorations in Australia, and referred, in conclusion, to the importance of undertaking further researches in the Antarctic regions. Mr. J. P. Thomson discussed recent explorations in British New Guinea; and Mr. D. Murray read extracts from the letters of Mr. Lindsay, who is exploring new regions in Western Australia. In his address, Mr. Fison made some general remarks on the method of studying aborigines, and concluded with a reference to British New Guinea as a promising field for important additions to anthropological science. Papers in this section seem to have been numerous and of wide interest. A lengthy report of the meeting will be found in *Nature* for March 3.

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An Alpine Club has been inaugurated in Odessa, having for its object the scientific exploration of the mountains of the Crimea. The new Club will publish original memoirs, and will also increase the facilities for tourists visiting the little-known southern uplands of Russia.

# CORRESPONDENCE.

## Butcher's Broom.

The Butcher's Broom, *Ruscus aculeatus*, flowers in March, but in the years 1884, 5, 6, 7, 1890, 1 it was flowering freely in November in Sussex and Hampshire. In November, 1888 and 1889, I was in London and could not observe it. Is this an instance of the premature opening of flower-buds that should lie dormant till next spring, or has the plant two flowering seasons in the year? Only a small number of the plants, perhaps one in fifty, produce any fruit, and it is difficult to find a bush bearing as many as a dozen berries. The November flowers seldom if ever produce fruit, the November-ripening berries being formed by the March flowers. Is the scarcity of fruit in this country connected with the premature opening of most of the flowers? Whatever may be the reason of this double flowering season, it seems to be a marked instance of the non-adaptation of a plant to present climatic conditions. Clement Reid.

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## *TO CORRESPONDENTS.*

*All communications for the* Editor *to be addressed to the* Editorial Offices, 67–69 *Chancery Lane, London, W.C.*

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Canker in Fruit Trees—(*W. H. Shrubsole, Sheerness*).—The varied and often extensive malformations to which the term "canker" is applied are not directly associated with any individual active agent. There is not the definite relation between the disease and a certain germ which obtains, for instance, in the potato-disease. The primary cause is an injury to the cambium layer, resulting in cessation of growth at the point affected. The injury is often inflicted at a very early age, and may be due to atmospheric causes, such as frost or hailstones, which have split or bruised the tender cortex, or to piercing by an insect, or some other accident. For instance, the disease often starts from the base of a branch which has died or become broken off, exposing the internal tissue.

The cambium ceases to produce wood and bark at the injured part, thus causing a break in the annual ring. If only atmospheric causes have come into play the sore may be small, and soon healed over by the growth of "callus" or healing-tissue from the margin of the wood. Frequently, however, complications ensue. The damp exposed tissue, full of nutritive sap, offers a favourable nidus for the germination of fungus spores. The resulting mycelium spreads through the surrounding cambium living upon and destroying the cells. Every year the parasite will spread further, remaining dormant through the winter as resting spores, while the efforts of the plant to heal over the gradually widening wound will lead to the formation of great lips of callus. The parasite often exercises a stimulating effect, causing, as in the case of insect-galls, hypertrophy of the surrounding tissues. The following are some of the principal works affording information on the subject:

1. Handbuch der Pflanzenkrankheiten. By P. Sorauer. Two parts. Berlin: Paul Parey, 1886. (A general text-book of plant diseases.)
2. Lehrbuch der Baumkrankheiten. By R. Hartig. Edit. 2. Berlin: Springer, 1889. (Deals with the diseases of trees.)
3. Timber and some of its Diseases. By H. Marshall Ward. London: Macmillan & Co. (Nature Series), 1889. (A small popular treatise.)